Installation Restoration Program
Final Basewide Groundwater Assessment Work Plan

143rd Combat Communications Squadron
Seattle Air National Guard Station
Washington Air National Guard
Seattle, Washington

August 2000

Air National Guard
Andrews AFB, Maryland

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LIST OF ACRONYMS/ABBREVIATIONS

Acronym/ Abbreviation	Definition
AGE	Aerospace Ground Equipment
ANG	Air National Guard
ANG/CEVR	Air National Guard/Civil Engineering Environmental Restoration Group
ANGS	Air National Guard Station
AOC	Area of concern
ARAR	Applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
AWQC	Ambient Water Quality Criteria
BGA	Basewide Groundwater Assessment
bgs	Below ground surface
Boeing	The Boeing Company
CCSQ	Combat Communications Squadron
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLARC II	Model Toxics Control Act Cleanup Levels and Risk Calculations
COC	Contaminant of concern
CPT	Cone penetrometer testing
DERP	Defense Environmental Restoration Program
DP	Direct-push
EDR	Environmental Data Resources, Inc.
EE/CA	Engineering Evaluation/Cost Analysis
ERM	Environmental Resources Management
FS	Feasibility Study
GPR	Ground penetrating radar
IDW	Investigation-derived waste
IRP	Installation Restoration Program
LTM	Long-term monitoring
MCLs	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
μg/kg	Micrograms per kilogram
μg/l	Micrograms per liter
mg/kg	Milligrams per kilogram
MTCA	Model Toxics Control Act

LIST OF ACRONYMS/ABBREVIATIONS

Acronym/ Abbreviation	Definition
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Act
PA	Preliminary Assessment
PA/SI	Preliminary Assessment/Site Inspection
PCE	Tetrachloroethene
pCi/g	PicoCuries per gram
PID	Photoionization detector
PREE/CA	Presumptive Remedy Engineering Evaluation/Cost Analysis
PSG	Project screening goal
PVC	Polyvinyl chloride
QA	Quality assurance
QA/QC	Quality assurance/quality control
QAPP	Quality Assurance Project Plan
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SI	Site Investigation
SMCL	Secondary Maximum Contaminant Level
SSHP	Sitewide Safety and Health Plan
SVOC	Semivolatile organic compound
TCE	Trichloroethene
TPH	Total petroleum hydrocarbons
TSD	Treatment, storage, or disposal
TVH	Total volatile hydrocarbon
UCL	Upper confidence limit
USEPA	United States Environmental Protection Agency
VOA	Volatile organics analysis
VOC	Volatile organic compound
WAC	Washington Administrative Code
WDOE	Washington Department of Ecology

SECTION 1.0

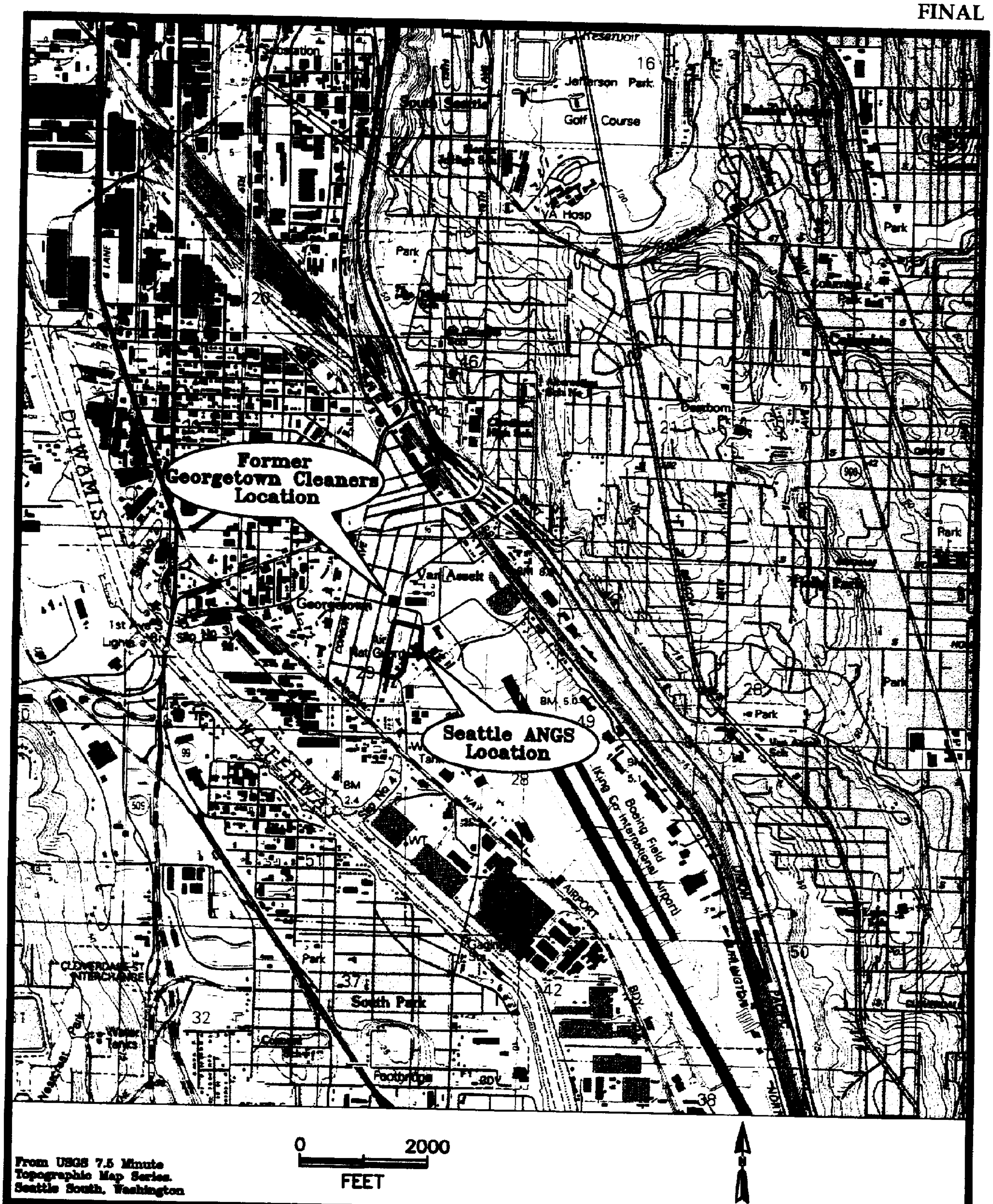
INTRODUCTION

This work plan describes the objectives, scope, and methods of the Basewide Groundwater Assessment (BGA) to be conducted at the Seattle Air National Guard Station (Seattle ANGS), 6736 Ellis Avenue South, Seattle, Washington (Figure 1-1). The planned work is part of the Air National Guard (ANG) Installation Restoration Program (IRP), and is being performed by Environmental Resources Management (ERM) under National Guard Bureau Contract DAHA90-94-0014. Technical and project management oversight of the work is provided by the Air National Guard/Installation Restoration Program Branch (ANG/CEVR).

A two-part Remedial Investigation (RI) and Feasibility Study (FS) was completed at the Seattle ANGS in 1999 (ERM 1999a and 1999b). The chlorinated volatile organic compounds (VOCs) tetrachloroethene (PCE) and trichloroethene (TCE) were detected above Washington State Model Toxics Control Act (MTCA) Method A Cleanup Levels in groundwater beneath the northern and southern portions of the Station, respectively. Groundwater monitoring has been conducted at the Station since September 1996; the maximum concentrations of PCE and TCE detected to date are 17 micrograms per liter (μg/l) and 83 μg/l, respectively. The MTCA Method A Cleanup Level for PCE and TCE is 5 μg/l.

During the RI, semivolatile organic compounds (SVOCs), total petroleum hydrocarbons, metals, and radionuclides were either not detected, were detected below MTCA Method A Cleanup Levels, or were consistent with area or regional background concentrations in soil and/or groundwater.

The source of the PCE and TCE detected in RI groundwater is unclear. Although interviews with site workers indicate that these compounds may have been used at the Seattle ANGS in the past, a source area of chlorinated VOCs was not identified in soil during the RI. Currently, there is insufficient data to rule out the possibility that the TCE in groundwater in the southern portion of the Station is related to the dissolved VOC plume beneath the Boeing Area 3-360 site immediately south of the Station (ERM 1999a). Concentrations of TCE as high as 1,300 μg/l have been observed in monitoring wells at this site [Landau



ERM	LOCATION MAP OF SEATTLE AIR NATIONAL GUARD STATION SEATTLE, WASHINGTON 143rd CCSQ, Seattle ANGS Seattle, Washington	FIGURE 1-1 G:\\6091\11\60911105.dwg

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and Associates (Landau) 2000]. However, groundwater monitoring data indicate that the Boeing Area 3-360 site is hydraulically downgradient of the Seattle ANGS; hence, the contaminant source and transport relationships between these two sites are not well defined. The PCE detected in groundwater in the northern portion of the Station may originate from a source upgradient of the Seattle ANGS.

1.1 Project Objective and Scope

The objective of the BGA project is to further define the geologic and hydrogeologic conditions at the Seattle ANGS and to evaluate whether man-made structures, historical events, or hydrologic conditions may have influenced groundwater flow beneath the Station in the past. The general scope of work includes: (1) a records search, (2) a field investigation, and (3) presentation of the BGA results in a Technical Memorandum. The specific work-scope elements are described in detail in subsequent sections of this work plan. The project scope addresses the following issues:

- The history of hazardous waste generation at the Seattle ANGS and neighboring properties;
- The groundwater flow conditions and contaminant concentrations at the Station and neighboring properties;
- The groundwater flow conditions at the Station boundaries, and groundwater regime response to seasonal effects and meteorological events;
- The possibility of sewer- or water-pipe ruptures or similar events in the past that may have temporarily affected groundwater flow direction or resulted in contaminant releases; and
- The possibility that groundwater flow directions or contaminant concentrations change with depth.

This work plan presents the approach and procedures of the planned field investigation. The records search was conducted concurrent with the work plan development so the results could be used to focus the field investigation on specific areas of potential concern identified during the records search. The scope and results of the records search are discussed in Section 2.2. The approach and procedures of the planned field investigation are described below and in Sections 3.0 through 7.0. Project organization and management will follow the general outline presented in the Phase II RI Work Plan (ERM 1998a).

1.2 General Investigation Approach

The field investigation will consist of the following tasks:

- Vertical lithologic profiling and discrete-depth groundwater sampling at 24 locations in the southern portion of the Station. The purpose of this task is to characterize the vertical distribution of dissolved VOCs, investigate possible stratigraphic controls on contaminant migration, and investigate evidence of a possible residual VOC source in the saturated zone.

- Vadose zone pore water sampling at 12 locations in the southern portion of the Station to investigate evidence for possible residual VOCs or vapor-phase transport in the vadose zone.

- Installation and sampling of three 40-foot-deep groundwater monitoring wells in the southern portion of the Station to evaluate dissolved VOC concentrations, groundwater flow directions at depth, and vertical potentiometric gradients.

- Continuous water level monitoring using downhole data-logging transducers in the northern and southern portions of the Station for 1 year. The purpose of this task is to investigate short- and long-term groundwater response to rainfall events, seasonal precipitation patterns, and other hydraulic inputs. The data will also be used to evaluate observed contaminant distribution in relation to the temporal variability in water table elevation and groundwater flow directions. In-well data loggers will be installed in eight monitoring wells for this purpose.

- Topographic survey of the Station, including surface elevation contours and site boundaries, surface drainage features, and the locations of other natural or cultural features (e.g., utility lines, buildings, and other structures).

Direct-push cone penetrometer testing (CPT) and sampling methods will be used to perform the vertical lithologic profiling and discrete-depth groundwater sampling. Groundwater and pore water samples will be analyzed for VOCs using United States Environmental Protection Agency (USEPA) methods.

1.3 Work Plan Structure

This BGA Work Plan provides a description of the planned field activities and is organized into nine sections and two appendices. The contents of the sections are as follows:

- Section 1.0 provides general introductory information.
- Section 2.0 discusses the nature and extent of contamination at the Seattle ANGS, summarizes the results of the records search, and presents the results of first-order solute transport modeling that was performed to evaluate the possibility of upgradient transport of dissolved TCE from the Boeing Area 3-360 site to the Seattle ANGS.
- Section 3.0 describes the permits required for the BGA field activities.
- Section 4.0 outlines the BGA investigative approach.
- Section 5.0 describes field investigation procedures.
- Section 6.0 describes sample collection procedures.
- Section 7.0 describes investigation-derived waste management.
- Section 8.0 outlines the project schedule and deliverables.
- Section 9.0 lists references.

The following appendices are included in this work plan:

- Appendix A - Sitewide Safety and Health Plan (SSHP).
- Appendix B - Quality Assurance Project Plan (QAPP).
- Appendic C - BGA Memorandum Outline.

SECTION 2.0

BACKGROUND

This section includes physical and historical information about the Seattle ANGS pertinent to the investigation outlined in this work plan.

2.1 Site Description

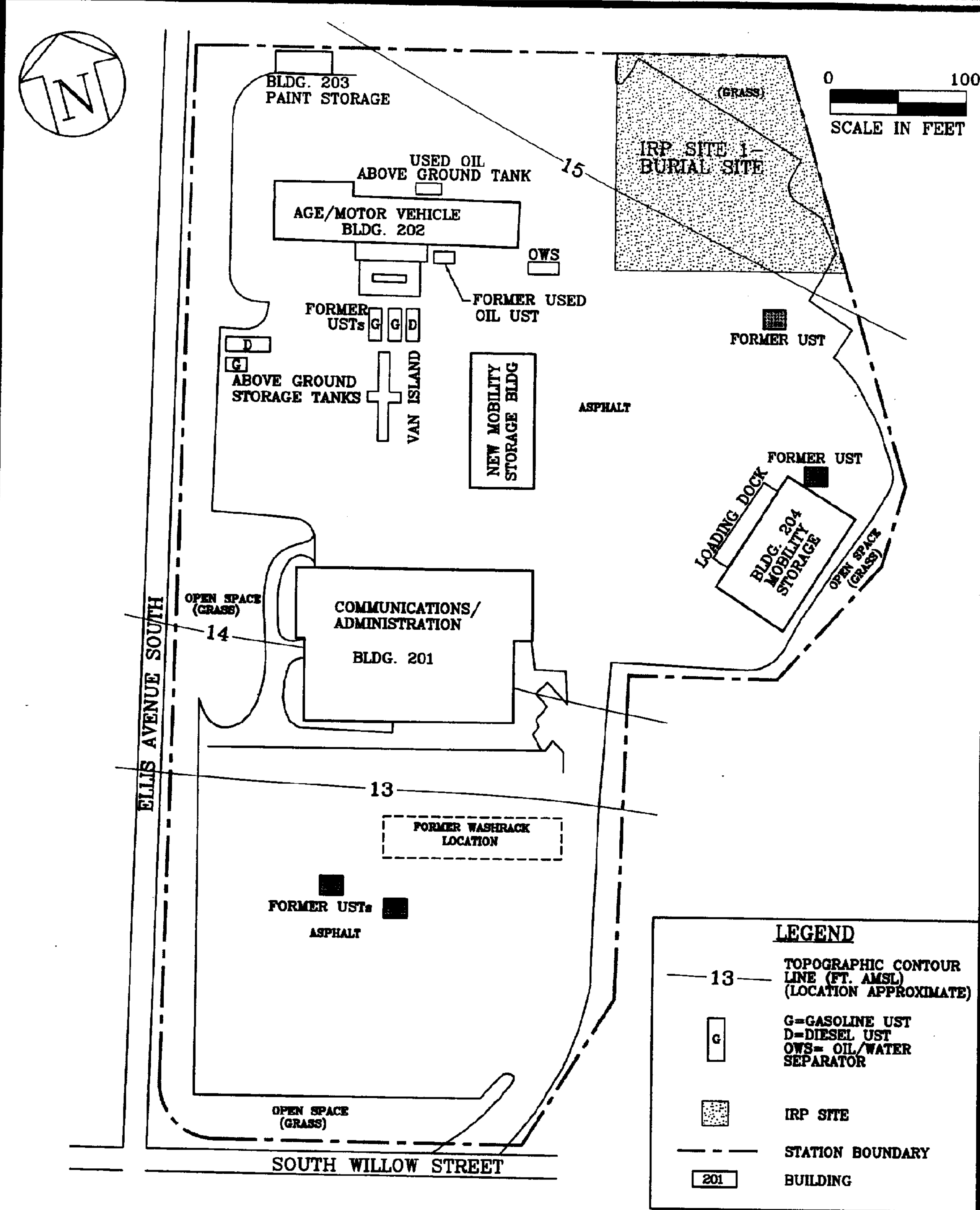
The Seattle ANGS is at 6736 Ellis Avenue South in Seattle, Washington (Figure 1-1). The Station occupies approximately 7.5 acres of land in the northwest portion of the King County International Airport (Boeing Field). The current layout of the Seattle ANGS is shown on Figure 2-1.

One IRP site has been identified at the Seattle ANGS. This site, designated as IRP Site 1 - Burial Site (the IRP site), is in the northeast corner of the Station (Figure 2-1). The IRP site is approximately 175 feet long by 175 feet wide and is covered with asphalt with the exception of the grass-covered northeast corner. The north and east sides of the IRP site are bounded by a 6-foot-high chain link fence that surrounds the entire Station.

The following text presents selected site information from the Phase II RI Report (ERM 1999a). A more detailed description of each topic is found in the RI Report.

2.1.1 Land Use

The Seattle ANGS is zoned for industrial use. Properties to the north, east, and south also are zoned for industrial use and have historically been used as such. Property to the west of the site (across Ellis Avenue South) is residential.



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SITE MAP

143rd CCSQ, Seattle ANGS
Seattle, Washington

FIGURE 2-1

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2.1.2 Topography

The Seattle ANGS is in King County in the Puget Sound Lowlands physiographic province. The Station is on flat, level terrain with a surface elevation of approximately 14 feet above mean sea level.

2.1.3 Climate

The climate in the Seattle area is characterized by mild summers and cool winters, with long spring and fall seasons. The average daily temperature ranges from 37 to 47 degrees Fahrenheit (°F) in the winter and from 55 to 72 °F in the summer.

The average annual precipitation is 38.84 inches, including 7.4 inches of snow. The greatest percentage of rainfall occurs from November to January. Free water surface evaporation in the Seattle area is approximately 25 inches per year, resulting in a net precipitation of 13.84 inches per year.

Prevailing wind is from the southwest, and the highest average wind speed of 9.8 miles per hour occurs in March.

2.1.4 Sensitive Receptors

There are no City of Seattle Water Department municipal wells within 4 miles of the Seattle ANGS and no private drinking water wells within 1 mile of the Station. The surrounding population obtains drinking water from municipal sources.

There are no critical habitats or endangered or threatened species identified within 4 miles of the Seattle ANGS.

2.1.5 Surface Water Hydrology

The Seattle ANGS is approximately 1/4 mile northeast of the Duwamish Waterway, a major surface water drainage for western Washington and a transportation channel for industrial South Seattle. The Duwamish Waterway was formed between 1917 and 1919 when the meanders of the Duwamish River within Seattle City limits were filled in with channel dredge material and material from other sources. The western end of the meander near North Boeing Field was not filled in; this portion of the river became the present-day Slip Number 4 (Figure 1-1). The Duwamish Waterway discharges into Elliot Bay on Puget Sound approximately 5.5 miles downstream (north) of the Station.

The Duwamish Waterway is the only fresh water body downgradient of the Station; it is not used for drinking water (Operational Technologies Corporation 1995). Surface runoff at the Seattle ANGS flows into a series of catch basins that are tied into the municipal storm sewer system. Figure 2-2 illustrates the surface water drainage system at the Station.

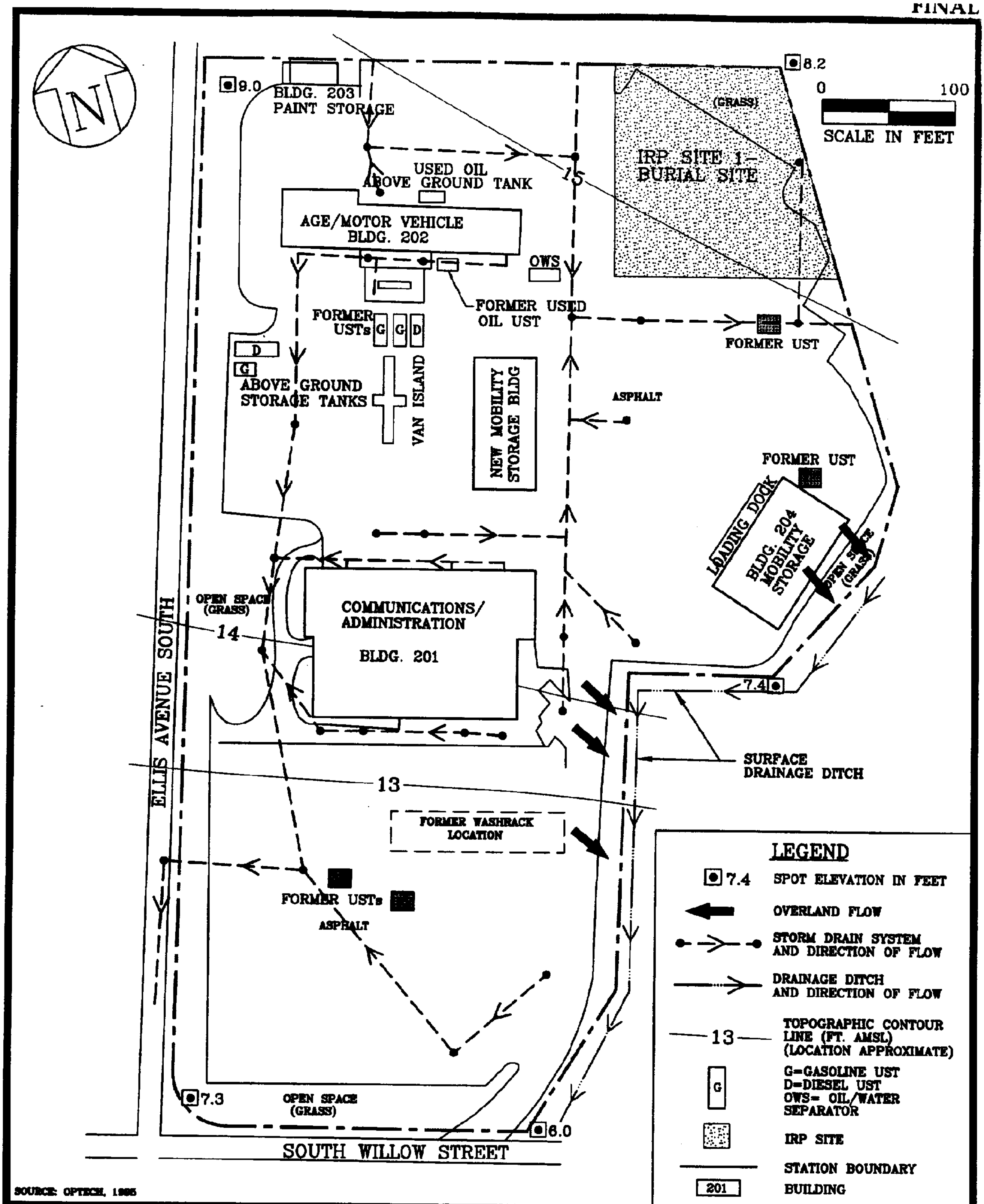
2.1.6 Site Geology

The near-surface geology at the Seattle ANGS is predominantly composed of two units. The first unit is a silty sand fill material present to a depth of approximately 8 feet below ground surface (bgs). The fill material is consistent with the descriptions of the material used to raise the Duwamish Valley grade for development in the 1910s. The second unit consists primarily of well-sorted, fine-grained sand (river alluvium) and is present from approximately 8 to at least 21.5 feet bgs, the maximum depth explored during the RI. Details regarding site geology are provided in the Phase II RI Report (ERM 1999a).

2.1.7 Local Hydrogeology

Unconfined groundwater occurs at a depth of 6 to 10 feet bgs, within the upper part of the recent river alluvium and the lower portion of the silty sand fill unit. The inferred groundwater flow direction is south toward the Duwamish Waterway, at an approximate gradient of 0.002 feet per foot. The depth to groundwater is influenced by seasonal precipitation; this influence has been documented by observations of up to 2 feet of increase in groundwater elevations during seasons with relatively high precipitation (ERM 1999a).

Based on slug tests conducted at monitoring well MW-3, hydraulic conductivity estimates are 1.25×10^{-4} to 6.09×10^{-4} feet per second, which are consistent with the predominant sand lithology observed in the shallow aquifer. Monitoring well construction data, groundwater elevation data, and representative potentiometric surface maps are provided in the Phase II RI Report (ERM 1999a).



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SURFACE WATER DRAINAGE MAP

143rd CCSQ, Seattle ANGS
Seattle, Washington

FIGURE 2-2

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2.1.8 Site History

The Seattle ANGS was constructed during World War II by the War Department and used by the Army and Air Force as an "Aircraft Factory School." In 1948, the property was given to King County as surplus property and was subsequently leased to the Washington ANG. The initial property was 17 acres and included 15 buildings, all of which were subsequently demolished. The squadron stationed at the Seattle ANGS went through several name changes and duty assignments. In 1988, the Seattle ANGS squadron acquired its current name, the 143rd Combat Communications Squadron (CCSQ). The 143rd CCSQ provides mobile communication equipment and support for airports and airfields.

The Seattle ANGS currently houses five buildings (Figure 2-1), which include the Paint Storage Building (Building 203), the Aerospace Ground Equipment (AGE)/Motor Vehicle Building (Building 202), the Mobility Storage Building (Building 204), the Communications/Administration Building (Building 201), and the New Mobility Storage Building. Other site features include miscellaneous aboveground storage tanks, a van island, and an oil/water separator. The Station previously had a washrack and several underground storage tanks (USTs) that are no longer present at the site.

Solid wastes generated from the 1950s through 1968 at the AGE/Motor Vehicle Maintenance Building, Power Production Building, and Communication/Administration Building were reportedly burned and/or buried at the IRP site or disposed off site. Wastes generated during this time period included radio tubes, solvents, waste motor oils, kerosene, batteries, brake fluid, spray paints, paint thinners/removers, methyl ethyl ketone, xylene, and naphtha.

Presently, hazardous wastes are collected and disposed by a licensed contractor or through the Defense Reutilization and Marketing Office at Fort Lewis, Washington.

2.1.9 Previous Investigations

Three IRP investigations have been conducted at the Seattle ANGS:

- A Preliminary Assessment (PA) was conducted by the ANG in December 1993.

- A Preliminary Assessment/Site Inspection (PA/SI) was conducted by Operational Technologies Corporation in 1994.

- A two-phase RI was conducted by ERM between 1996 and 1999.

The PA focused on identification and evaluation of historic and current use, handling, and disposal practices of hazardous materials and hazardous waste at the Seattle ANGS. Based on the PA results, one area of concern (subsequently designated IRP Site 1 - Burial Site) was identified as being potentially contaminated with hazardous materials and/or waste, thus warranting further IRP investigation.

The objective of the PA/SI was to identify IRP sites and to confirm the presence or absence of soil and groundwater contamination associated with past hazardous material and hazardous waste handling and disposal practices. Field activities for the PA/SI included screening and confirmation activities. The screening activities at the IRP site included a soil vapor survey, a ground-penetrating radar survey, and a magnetometer survey. Confirmation activities included collection of soil samples from three soil borings and one monitoring well boring and the installation and sampling of three groundwater monitoring wells. Constituents detected at concentrations above MTCA Cleanup Levels and/or site-specific background concentrations during the PA/SI include total petroleum hydrocarbons (TPH) in soil, gross alpha and gross beta radiation in soil and groundwater, and metals in groundwater.

The objective of the RI was to evaluate the nature and extent of contamination associated with the IRP site. The RI was conducted in two phases. Field activities for the Phase I RI included screening and confirmation activities. The screening activities included organic vapor screening and TPH screening of soil samples. Confirmation activities included the collection and analysis of 22 direct-push groundwater samples, 10 surface soil samples, 2 storm sewer catch basin samples, and subsurface soil samples from 11 soil borings. Additional Phase I RI activities included installation of five groundwater monitoring wells, quarterly sampling of the RI and PA/SI monitoring wells for 1 year, and aquifer slug testing to estimate hydraulic conductivity.

Field activities for the Phase II RI included soil vapor sampling at 40 locations across the site, direct-push soil and groundwater sampling at 20 locations, installation of five groundwater monitoring wells, and quarterly groundwater monitoring for 1 year. Complete analytical testing results; sampling location maps; and a summary of the samples collected, analyses conducted during the RI, and interpretation of the RI data are presented in the Phase I and II RI Reports (ERM 1998b and ERM 1999a).

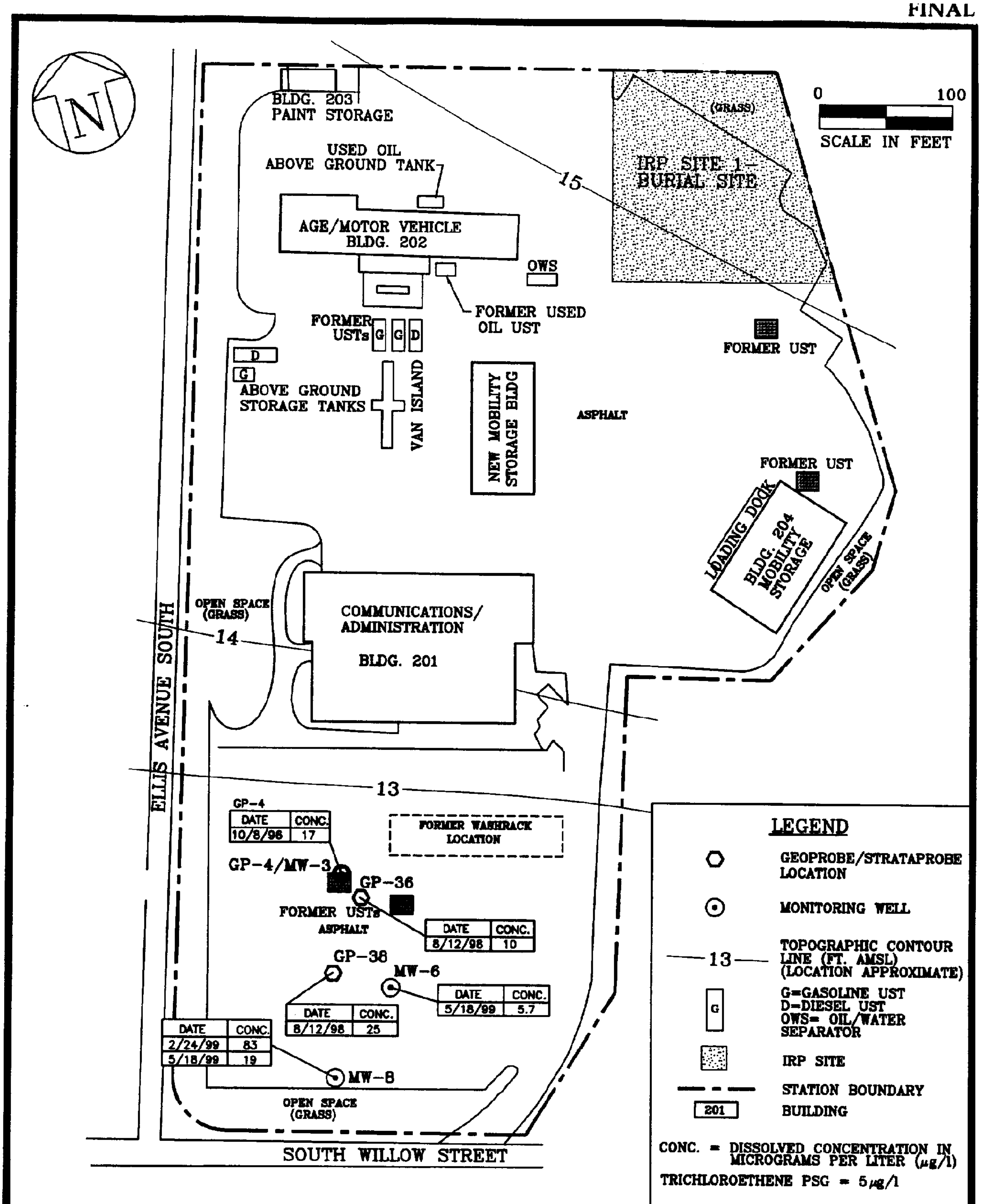
Numeric project screening goals (PSGs) were developed during the RI for use in identifying COCs in soil and groundwater. The PSGs were derived from State and Federal applicable or relevant and appropriate requirements (ARARs) and are included in the Phase II RI report (ERM 1999a). TCE in groundwater is the only COC identified at the Seattle ANGS that is considered to pose a potential threat to human health or the environment. The PCE concentrations detected in groundwater are not persistent, and PCE is not considered a contaminant of concern for significant risk to human health and/or the environment at the Seattle ANGS.

2.1.10 Nature and Extent of Contamination

TCE has been detected in groundwater samples collected from the southern portion of the Station. The samples were collected from both direct-push (i.e., Geoprobe™/StrataProbe™) borings and groundwater monitoring wells installed during the RI. The RI results for TCE in groundwater are summarized in the Phase II RI Report (ERM 1999a). TCE was detected in direct-push samples GP-2, GP-4, GP-5, GP-36, GP-37, and GP-38 at concentrations ranging from 1.0 to 25 micrograms per liter (µg/l). TCE also has been detected in groundwater samples collected from monitoring wells MW-4, MW-5, MW-6, MW-7, and MW-8 at concentrations ranging from 2.0 to 83 µg/l. Concentrations of TCE detected at greater than the MTCA Method A Cleanup Level of 5 µg/l in groundwater samples are shown on Figure 2-3.

The direct-push groundwater sample results are considered screening-level data with regard to regulatory compliance. The groundwater samples collected from monitoring wells, on the other hand, provide definitive data for groundwater characterization. The groundwater sample collected from monitoring well MW-8 in February 1999 (83 µg/l), and the samples collected from wells MW-6 and MW-8 in May 1999 (5.7 and 19 µg/l, respectively), exceeded the MTCA Method A Cleanup Level for TCE of 5 µg/l (Figure 2-3).

An on-site source area for TCE detected in groundwater has not been identified at the Station. Of 27 soil samples analyzed for VOCs during the RI, only one was found to contain TCE. The TCE concentration reported in this sample (0.17 milligrams per kilogram) was below the MTCA Method A Cleanup Level of 0.5 milligrams per kilogram. Furthermore,



GP-4

DATE	CONC.
10/8/98	17

GP-36

DATE	CONC.
8/12/98	10

GP-38

DATE	CONC.
8/12/98	25

MW-6

DATE	CONC.
5/18/99	5.7

MW-8

DATE	CONC.
2/24/99	83
5/18/99	19

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DETECTIONS OF TRICHLOROETHENE
ABOVE PROJECT SCREENING
GOALS IN GROUNDWATER
143rd CCSQ, Seattle ANGS
Seattle, Washington

FIGURE 2-3

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this soil sample was collected at the depth of the water table in the boring for monitoring well MW-3, and thus may have contained TCE-impacted groundwater that biased the analytical results. Chlorinated VOCs were not detected in the other RI soil samples. As discussed in the Phase II RI Report (ERM 1999a), there are insufficient data to rule out the possibility that the TCE detected in groundwater at the Seattle ANGS is related to groundwater contamination at the Boeing facility immediately south of the Station.

PCE has been detected in groundwater samples collected from monitoring well BS-004PZ at concentrations ranging from 3.1 to 17 µg/l. The PSG for PCE is 5 µg/l. An on-site source area for the PCE detected in groundwater has not been identified at the Station. PCE was not detected in the 27 soil samples analyzed for VOCs during the RI.

2.1.11 Contaminant Fate and Transport

The fate and transport of TCE, as discussed in the Phase II RI Report, is summarized as follows. Transport in groundwater is assumed to be the primary route of migration for TCE at the Seattle ANGS. In general, fate and transport of TCE in groundwater is controlled by its affinity for organic carbon constituents in soil, rates of biodegradation and biokinetic decay, and the solubility-based diffusive dilution of the compound in the saturated zone. Transport of TCE in groundwater can be impeded by its adsorption to organic material in soil and its tendency to volatilize, and to a lesser degree by natural degradation processes. Degradation of TCE through aerobic, anaerobic, or abiotic processes at the Seattle ANGS is difficult to assess because analytical testing conducted to date has not included the full suite of expected degradation products (e.g., ethene and ethane) or the relevant indicator chemicals. Although low levels of an intermediate degradation product (cis-1,2-dichloroethene) have been detected in one monitoring well (MW-5), the data are too sparse to draw definitive conclusions.

2.1.12 Baseline Risk Assessment

A preliminary baseline risk assessment was conducted as part of the RI to evaluate the potential for TCE in groundwater at the Station to cause adverse health effects in exposed individuals via ingestion of TCE-contaminated drinking water. Using the risk evaluation methods described in the Phase II RI report (ERM 1999a), the estimated cancer risk associated with the maximum TCE concentration detected in monitoring wells during the RI (83 μg/l) is 2.09×10^{-5}. This value exceeds the Washington Department of Ecology (WDOE) acceptable cancer risk level of 1×10^{-6} for individual hazardous substances.

2.2 Records Search

As part of the BGA, a records search was conducted to gather information on potential sources of the chlorinated VOCs detected in groundwater at the Seattle ANGS. The records search expanded on the regulatory records review that was conducted during development of the Phase I RI/FS Work Plan (ERM 1996). Regulatory files, aerial photographs, and other sources were researched for information about industrial sites adjacent to the Station. Items of interest included historical operations, chemical usage, and waste disposal practices, as well as site-characterization data from environmental investigations. Other items researched include locations of underground utilities in the area and the location of the former (now-filled) Duwamish River Channel north of Slip Number 4 (see Figure 1-1).

The records search utilized the following information sources:

- WDOE Toxics Cleanup Program and Resource Conservation and Recovery Act (RCRA) site files;
- Dangerous Waste Notification Forms/Annual Hazardous Waste Generator Reports on file at the WDOE and the USEPA Region 10 office;
- Fire inspection records and hazardous material permits on file at the Seattle and Redmond, Washington fire departments;
- Aerial photographs of the North Boeing Field area covering the period 1946 to 1990;
- Polk address directories for the city of Seattle covering the period 1942 to 1996;
- Sanborn fire insurance maps of the Seattle ANGS area from 1949 and 1966;
- The Seattle Public Library;

- Seattle Public Utilities;
- Seattle City Light; and
- The Boeing Company.

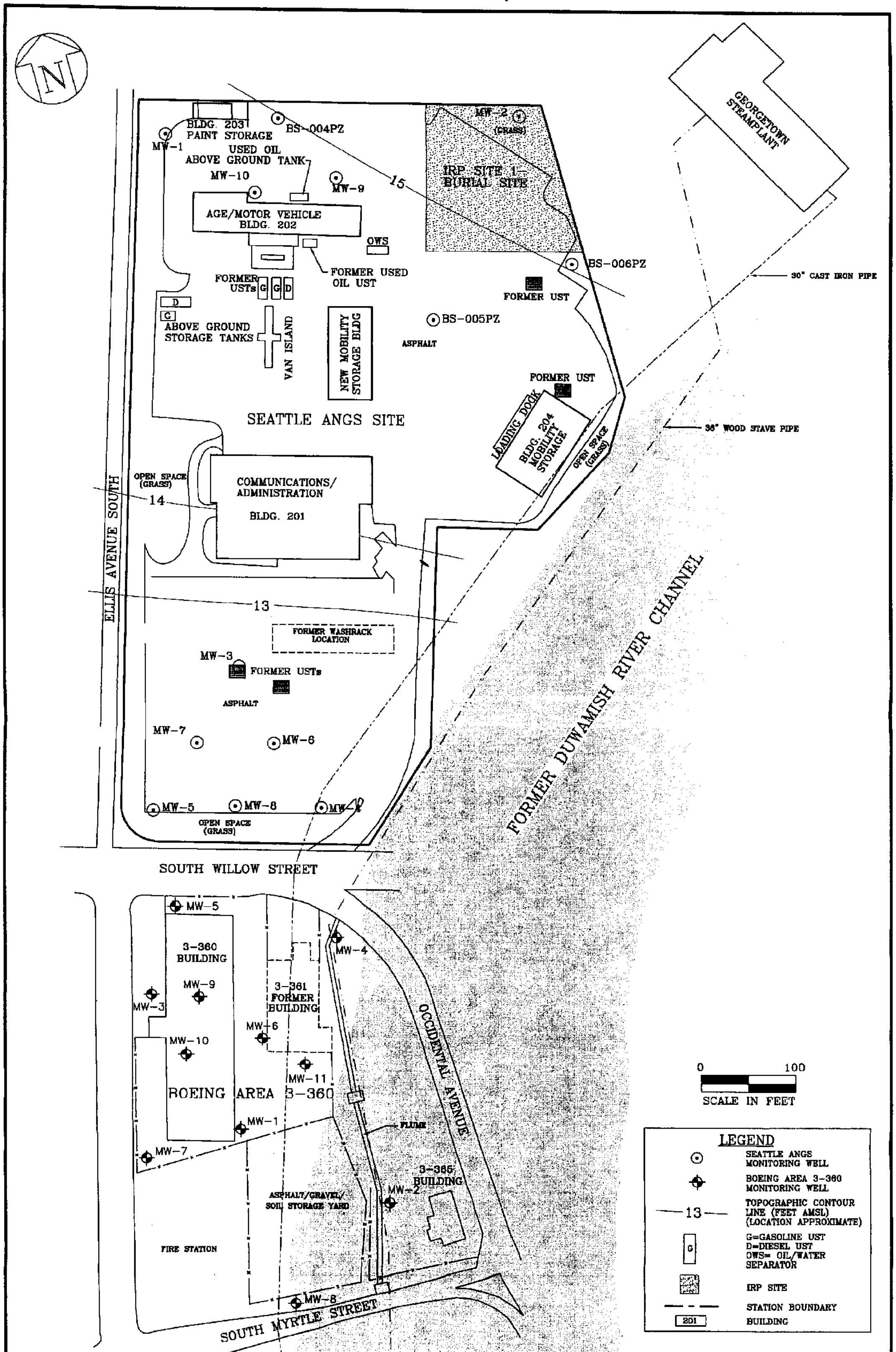
The WDOE file review conducted in 1996 prior to the Phase I RI indicated that the only site in the vicinity of the Seattle ANGS with known chlorinated VOC contamination was the Boeing Area 3-360 site (ERM 1996). The file review conducted as part of the current records search confirmed this finding. Consequently, the current search focused on obtaining historical and site characterization information for the Boeing Area 3-360 site (Figure 2-4), and evaluating the types and locations of underground structures (e.g., utility trenches) that may control subsurface contaminant migration at the Boeing site and the Seattle ANGS.

2.2.1 Boeing Area 3-360 Site Discussion

A potentiometric surface map showing the most recent available groundwater level data from both the Seattle ANGS and the Boeing Area 3-360 site is shown on Figure 2-5. Groundwater flow direction on these maps is generally consistent with available data from several monitoring events recorded at the Seattle ANGS and available information for the Area 3-360 site.

Figure 2-6 shows dissolved TCE concentrations beneath the Boeing Area 3-360 site and the Seattle ANGS based on groundwater sampling conducted in July and September 1998; Figure 2-7 shows the TCE concentrations in February 2000. Site investigation and data summary reports for the Area 3-360 site contained in WDOE files and obtained from the Boeing Company (SEACOR 1996, Boeing 1998, and Landau Associates 2000) indicate that TCE has been detected at concentrations up to 1,300 µg/l in shallow groundwater beneath the Area 3-360 site. The highest concentrations of dissolved TCE have consistently been detected in groundwater samples collected from wells directly under and downgradient (south) of Building 3-360.

TCE was not detected in eight Area 3-360 subsurface soil samples collected and analyzed for VOCs in 1991 and 1995 at the boring locations shown on Figure 2-8. It is important to note that only four soil samples (one each from borings HA-2, SB-2, MW-9, and MW-10) collected along the 640-foot perimeter (i.e., directly beneath or within 30 feet) of Building 3-360 (the presumed TCE source area) were analyzed for VOCs.



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BOEING AREA 3-360
LOCATION MAP

143rd CCSQ, Seattle ANGS
Seattle, Washington

FIGURE 2-4

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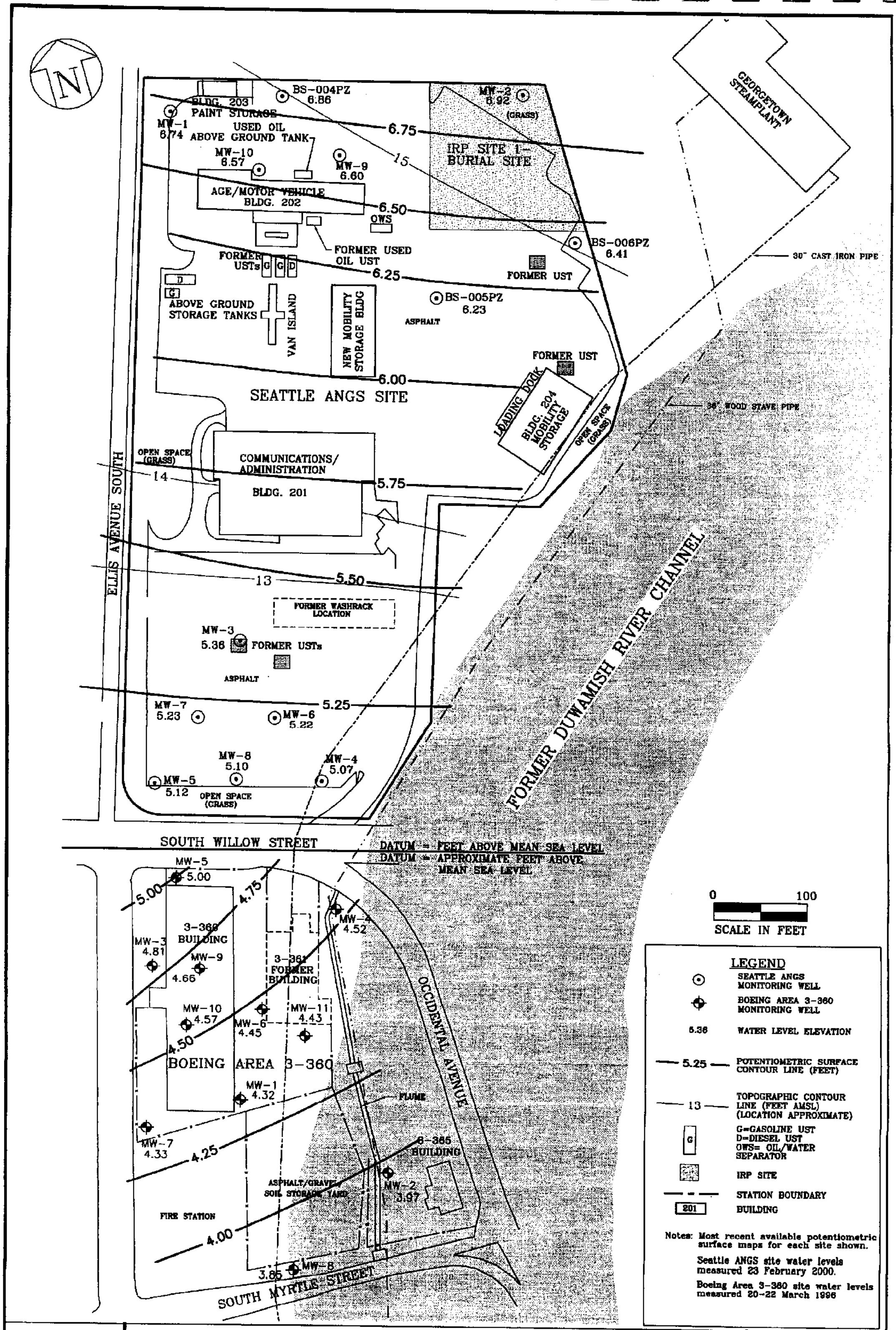

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POTENTIOMETRIC SURFACE MAP

143rd CCSQ, Seattle ANGS
Seattle, Washington

FIGURE 2-5

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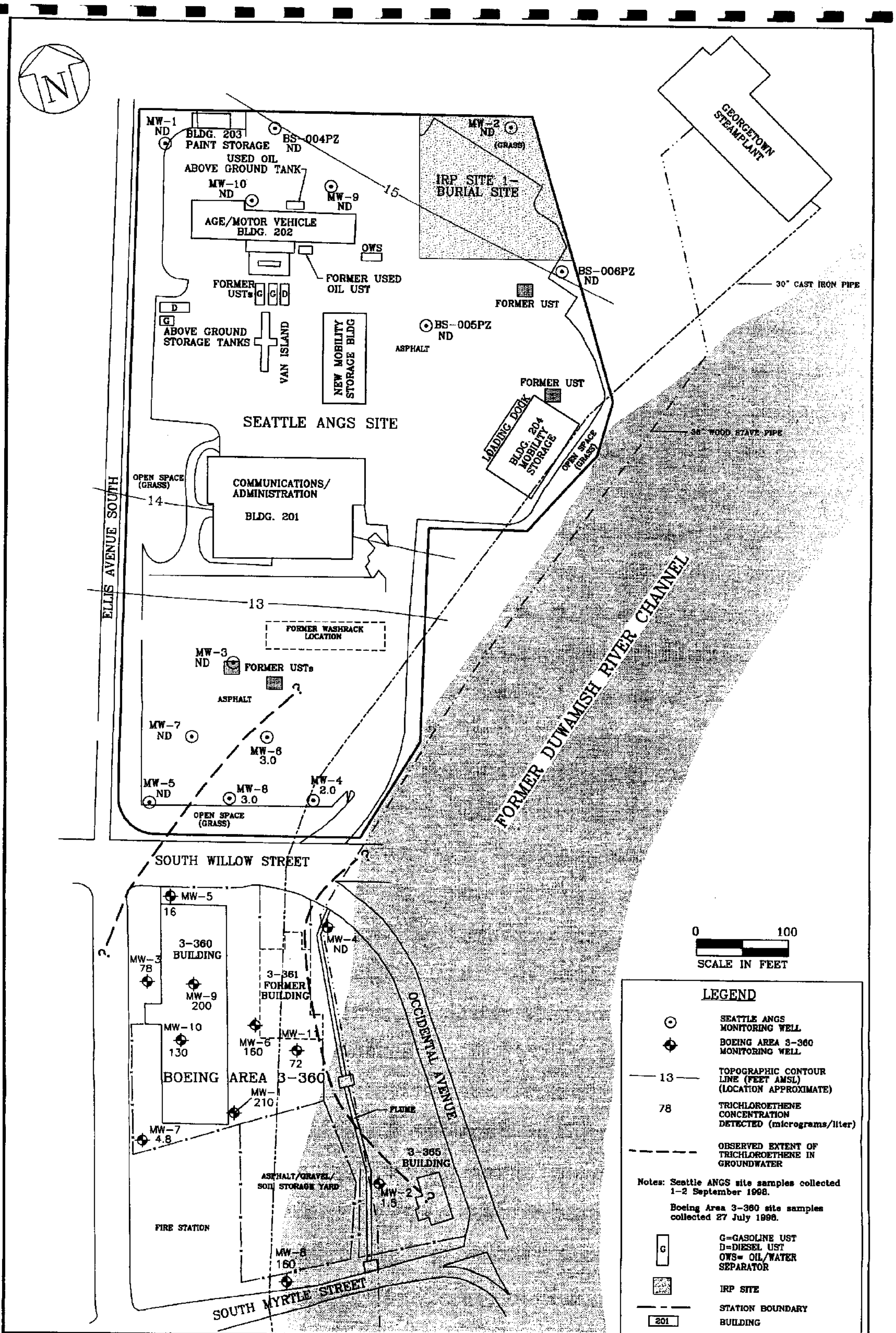

TRICHLOROETHENE IN GROUNDWATER SAMPLES JULY/SEPTEMBER 1998

143rd CCSQ, Seattle ANGS
Seattle, Washington

FIGURE 2-6

FINAL

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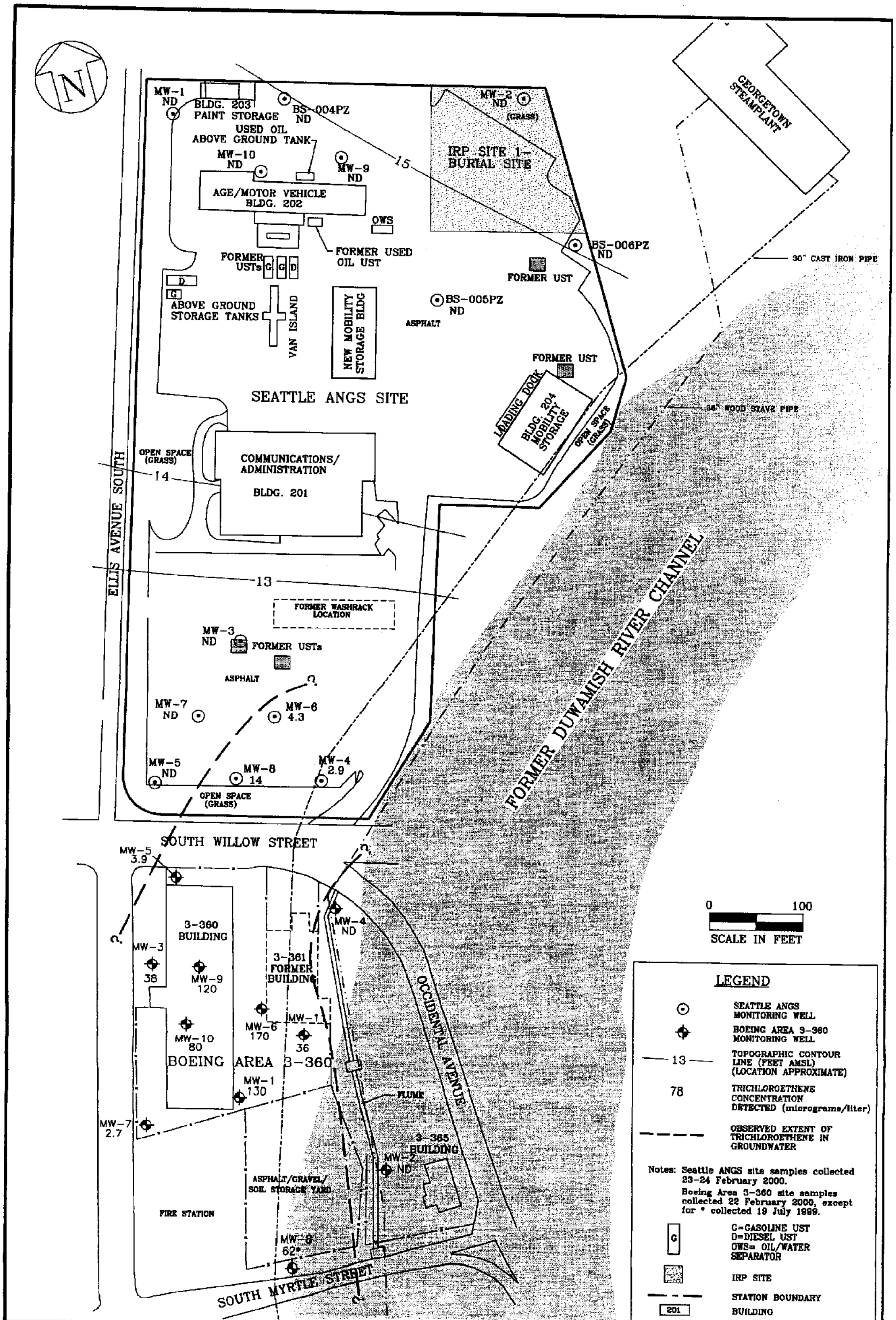

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TRICHLOROETHENE IN GROUNDWATER SAMPLES
FEBRUARY 2000

143rd CCSQ, Seattle ANGS
Seattle, Washington

FIGURE 2-7

FINAL

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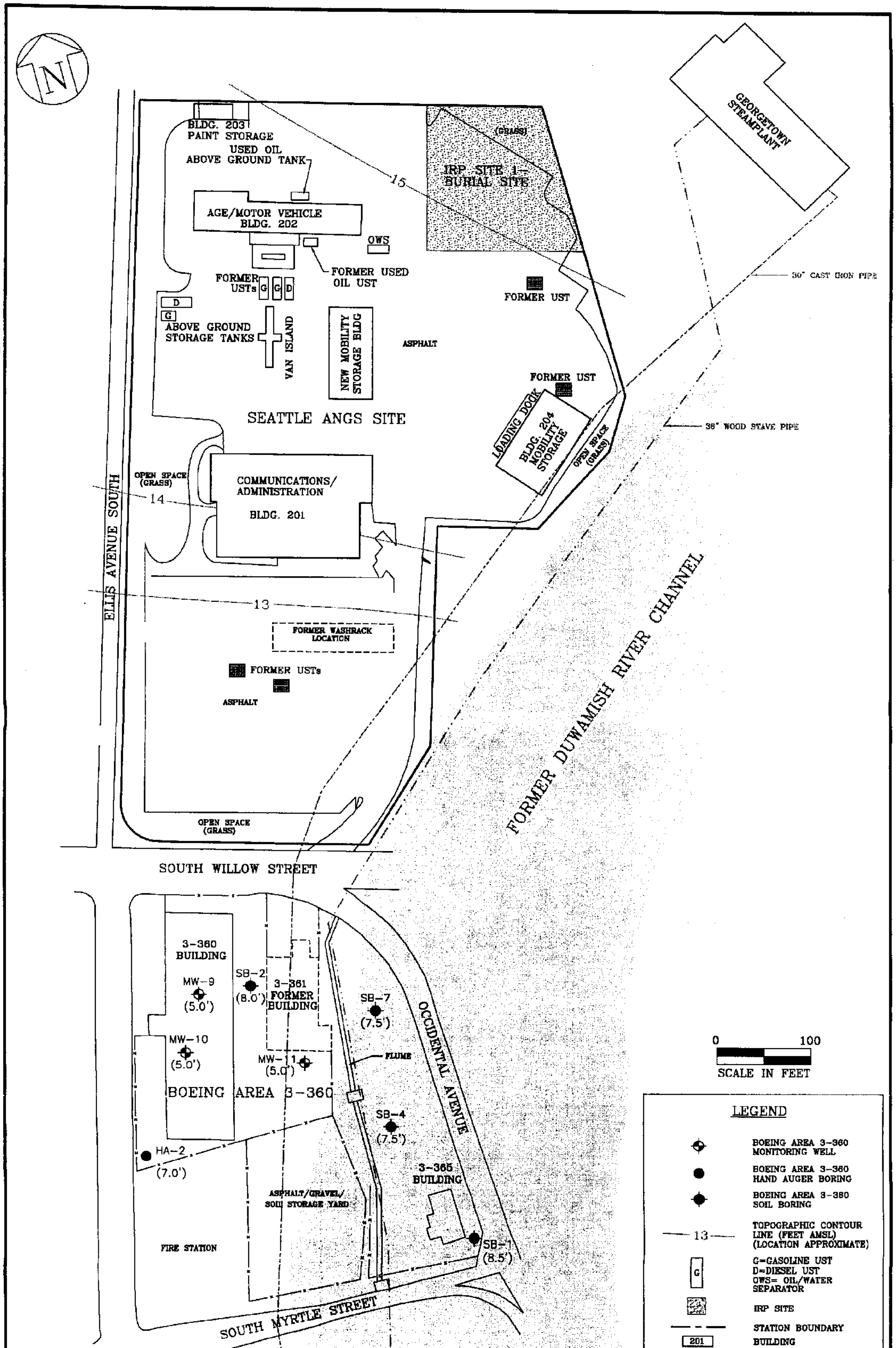

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BOEING AREA 3-360 LOCATIONS OF SUBSURFACE SOIL SAMPLES ANALYZED FOR VOLATILE ORGANIC COMPOUNDS

143rd CCSQ, Seattle ANGS
Seattle, Washington

FIGURE 2-8

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The referenced reports on the Area 3-360 site do not discuss possible sources of the chlorinated VOCs detected in groundwater. The Boeing Company has indicated that it has not used TCE or other chlorinated solvents at the site. However, it was learned during the records search that the Area 3-360 property is owned by the county, and that the site was occupied from 1973 until 1978 by the EMF Corporation (EMF). Information obtained from the Seattle Public Library indicates that EMF manufactured high-speed, high-volume paper handling and sorting machines at the Area 3-360 site for industry and government clients. In addition to EMF's corporate offices, facilities and operations at the site included a metal fabrication shop, a paint shop, electronics manufacturing, and mechanical assembly. In 1978 EMF moved their headquarters and production facilities to Redmond, Washington.

2.2.2 Hazardous Waste Records and Fire Inspection Reports for EMF Corporation and Seattle ANGS

State and Federal hazardous waste records and local fire inspection reports from the 1980s indicate that EMF used TCE in their manufacturing process. The earliest such record is a 1980 hazardous materials permit application submitted by EMF to the City of Redmond; this application indicates that TCE was stored outside in 55-gallon drums at EMF's Redmond facility. Dangerous Waste Notification Forms submitted by EMF to the WDOE in 1985 and 1986 indicate that the company generated a total of 10,634 pounds (871 gallons) of spent TCE in 1984 and 1985.

Hazardous waste records from EMF's operations prior to 1980 were not available (RCRA reporting requirements weren't widely implemented until the early 1980s). However, the nature of their manufacturing operations and the records from the 1980s suggest that EMF may have used and stored TCE at the Area 3-360 site in the mid-1970s.

Hazardous waste records and fire inspection reports also were obtained for the Seattle ANGS site. Generator Annual Dangerous Waste Reports submitted by the ANG to the WDOE indicate that small quantities of spent PCE were generated at the Station in 1991 and 1992. However, none of the records reviewed indicate that TCE was used or stored at the Station.

2.2.3 Location of Underground Utilities and Former Duwamish River Channel

The King County Drainage and Wastewater Division, King County Surface Water Management Unit, Seattle Public Utilities, Metro, and Seattle City Light were contacted regarding the location and structural condition of underground utilities in the vicinity of the Seattle ANGS and the Area 3-360 site. There were no records of pipe ruptures, leaks, or other defects in water or sewer trunk lines beneath Ellis Avenue South and adjoining streets that may have influenced the local groundwater regime. The subject agencies had no records of maintenance or repairs to side sewers or water service connections in the vicinity of the Station.

The only significant underground utility identified during the records search that might potentially influence subsurface contaminant migration between the Area 3-360 site and the Seattle ANGS consists of two cooling-water supply lines for the inactive Georgetown Steam Plant. This steam plant is approximately 200 feet east of the northeast corner of the Seattle ANGS (Figure 2-4) and is owned by Seattle City Light. The plant was built in 1906 and operated until approximately 1979. Information regarding the cooling-water lines was obtained from Seattle City Light.

The 30- and 36-inch diameter cooling-water lines were installed in approximately 1912 and 1918, during and shortly after the time the former Duwamish River Channel was filled. Both water lines were installed along the former west bank of the river channel and were fed by pumps on the east bank of the Duwamish Waterway, just north of Slip Number 4. Figure 2-4 shows the location of these water lines and the location of the former Duwamish River Channel relative to the Seattle ANGS and the Area 3-360 site. After the cooling water cycled through the condensers in the steam plant, it flowed into a concrete open-box flume that conveyed the water southward along the eastern boundary of the Seattle ANGS and Area 3-360. The spent cooling water flowed through culvert pipes under East Marginal Way and was discharged to the Duwamish Waterway at Slip Number 4.

Construction drawings of the cooling-water lines supplied by Seattle City Light indicate that the lines were installed at a depth of approximately 8 feet bgs in the vicinity of the Seattle ANGS and Area 3-360, which is the approximate depth of the water table. The 30-inch line is made of cast iron and the 36-inch line is made of wood staves (narrow strips of wood placed edge to edge, similar to a wooden barrel). As-built drawings of the piping trenches are not available; however, the trenches were likely backfilled with a relatively permeable sand material.

As shown on Figures 2-6 and 2-7, the observed dissolved TCE plume beneath the Seattle ANGS and Area 3-360 is aligned in the same general orientation as the former Duwamish River Channel and the cooling-water supply lines for the Georgetown Steam Plant. The eastern edge of the plume coincides very nearly with the location of the 36-inch-diameter wood stave pipe. This alignment suggests that the filled river channel and/or cooling-water lines may influence groundwater flow patterns and the TCE plume distribution.

2.2.4 Solute Transport Modeling

A solute transport model was developed to simulate groundwater transport of TCE from an assumed source on the Area 3-360 site to evaluate the potential effects of aquifer conditions on the distribution of TCE over time. The two-dimensional solute transport model was constructed using Visual MODFLOW. This widely used groundwater modeling package uses the computer programs MODFLOW and FT3D to solve the coupled groundwater flow and solute transport equations using the method of finite differences. The source area in the model was assumed to be under Building 3-360 and was assumed to comprise a "smear zone" of residual adsorbed-phase TCE producing a constant TCE concentration in groundwater. Other model assumptions were as follows:

- Every 2 years, a 2-year, 24-hour rainfall event (locally established as 2 inches of rain in 24 hours [National Oceanic and Atmospheric Administration 2000]) was assumed to occur. All of the rain that fell on Building 3-360 during these events was assumed to recharge the shallow water table beneath the building through the French drain surrounding the building (the building's rain gutters and downspouts feed into this French drain). Recharge was assumed to be zero everywhere else in the model (the majority of the Seattle ANGS and Area 3-360 sites are paved).

- The TCE release was assumed to occur in 1975, when the EMF Corporation occupied the Area 3-360 site.

- The 36-inch-diameter wood stave cooling-water pipe that passes under Area 3-360 was assumed to leak water at a constant rate from 1975 until 1979, the year the Georgetown Steam Plant was decommissioned.

- The steady-state groundwater flow direction was assumed to be toward the south; the hydraulic gradient was assumed to be 0.0025 feet per foot.

- The effects of retardation, degradation, and volatilization on TCE transport were not included in the model.

The model was run several times to predict how the dissolved TCE plume would evolve over a 25-year period. Each time the model was run, select input parameters were varied to evaluate whether certain combinations of variables could produce the plume geometry and TCE concentrations observed today (Figure 2-7). Input parameters that were varied include the hydraulic conductivity distribution in the saturated zone, the (constant) TCE concentrations in the source area, and the wood stave pipe leakage rate.

It was found that a reasonable approximation of the observed TCE plume could be obtained by using the following input parameter values:

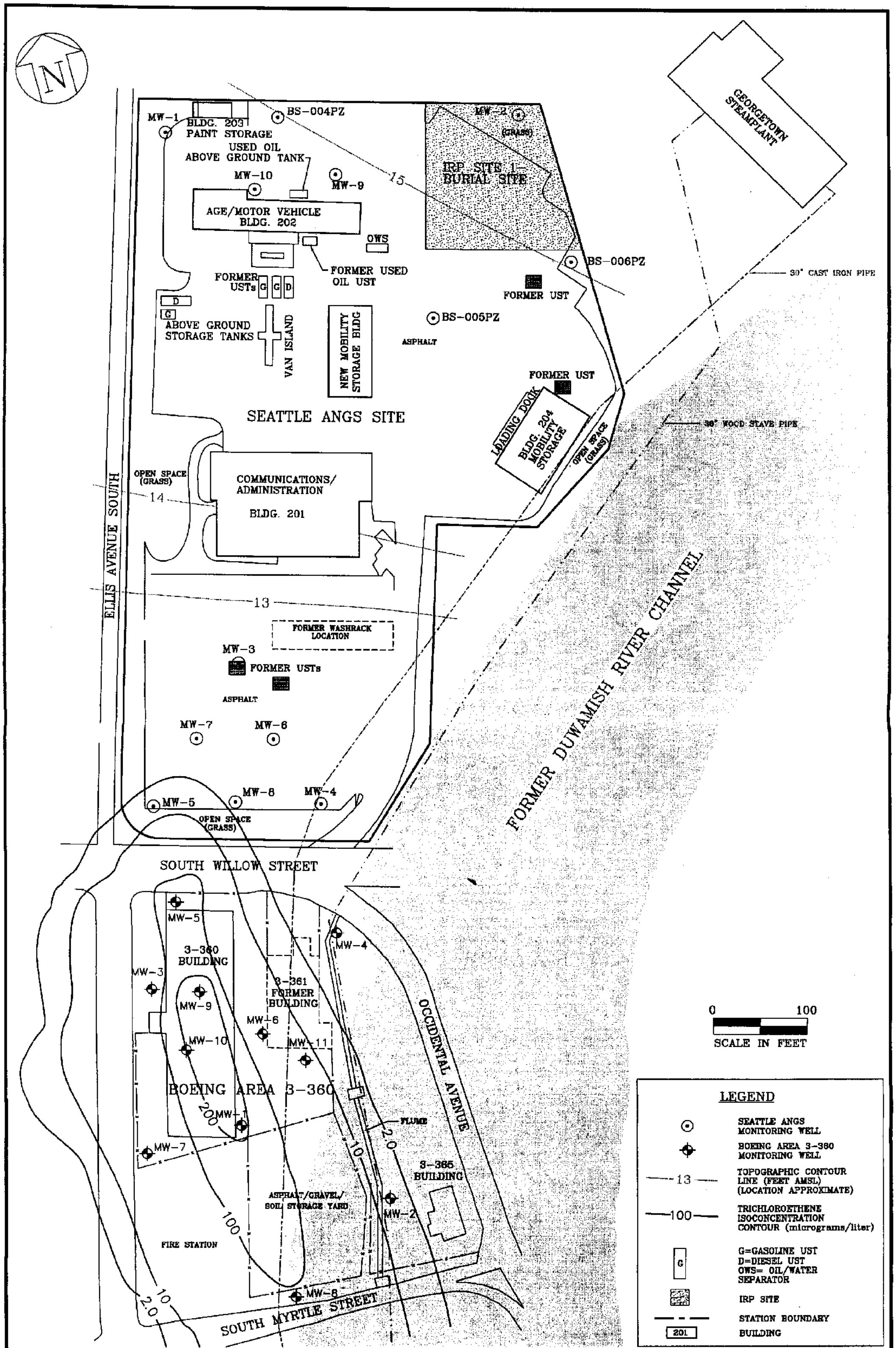
- TCE source concentration = 150 µg/l under the northern half of Building 3-360 and 300 µg/l under the southern half;

- Hydraulic conductivity = 5 feet per day (ft/day) under the Seattle ANGS and Area 3-360, and 0.3 ft/day in the former Duwamish River Channel and under the residential area west of Ellis Avenue South; and

- Wood stave pipe leakage rate = 0.26 gallons per day per linear foot.

A "snapshot" of the model-predicted plume conditions after 25 years is shown on Figure 2-9. The model results indicate that the TCE plume spreads northward as a result of temporary groundwater mounding beneath Building 3-360 during the 2-year, 24-hour rainfall events. This mounding, shown on Figure 2-10, temporarily reverses the groundwater flow direction from south to north in the area immediately north of Building 3-360.

The modeling results presented on Figures 2-9 and 2-10 do not indicate that the TCE observed in groundwater beneath the Seattle ANGS definitely originated from a source on the Area 3-360 property. The results do, however, suggest a possible mechanism for the "upgradient" transport of dissolved TCE from an assumed source at the Area 3-360 site.



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SOLUTE TRANSPORT MODELING RESULTS
BOEING AREA 3-360 TRICHLOROETHENE RELEASE
25-YEAR DURATION

143rd CCSQ, Seattle ANGS
Seattle, Washington

FIGURE 2-9

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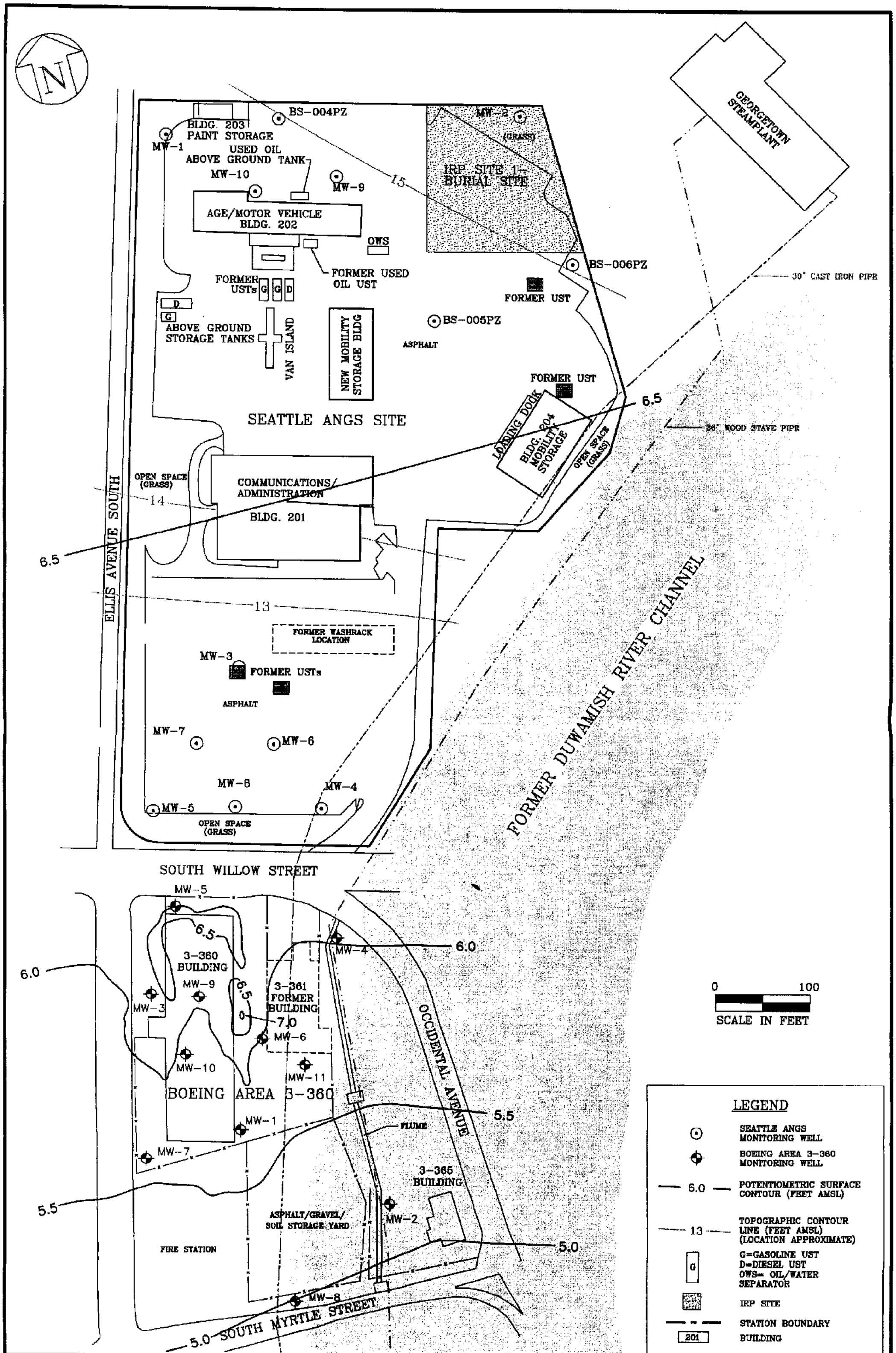

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SOLUTE TRANSPORT MODELING RESULTS
POTENTIOMETRIC SURFACE AFTER 2-YEAR,
24-HOUR INTENSITY RAINFALL EVENT
143rd CCSQ, Seattle ANGS
Seattle, Washington

FIGURE 2-10

FINAL

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Although the model assumptions and input parameter values seem reasonable given the available information, there are many uncertainties that make it difficult to draw definitive conclusions from the modeling results alone. For example, the hydraulic conductivity values and distribution used in the model may not be an accurate representation of the true distribution. The hydraulic conductivity value of 5 ft/day used in the model for the conductivity under the Seattle ANGS and Area 3-360 is comparable to the low estimate of 11 ft/day derived from slug tests in monitoring well MW-3 at the Seattle ANGS. However, no estimates of hydraulic conductivity are available for the former Duwamish River Channel or for the area west of Ellis Avenue South for comparison to the model values. The model prediction of temporary groundwater mounding and flow reversals beneath Building 3-360 during intense rainfall events can be tested through continuous water level monitoring. Continuous water level monitoring will be performed as part of the BGA project.

2.2.5 Georgetown Cleaners Site

One other site of potential interest was identified during the BGA records search. A business known as Georgetown Cleaners was listed at 6525 Ellis Avenue South in the 1983 and 1985 editions of the Seattle Polk directory. This site is approximately 300 feet north (upgradient) of the Seattle ANGS, on the northwest corner of Ellis Avenue South and Warsaw Street (Figure 1-1). The PCE detections in monitoring wells BS-004PZ, BS-005PZ, MW-1, and MW-9 in the northern portion of the Station may be related to this site, as PCE is a common chemical used in dry cleaning. However, no records concerning this site were found in the WDOE files.

SECTION 3.0

PERMITS

The installation of direct-push borings, lysimeters, and groundwater monitoring wells during the BGA will require submittal of a Notice of Intent to Construct a Monitoring/Resource Protection Well to the WDOE at least 3 days prior to commencing work at the site. This notice will be submitted by the drilling subcontractor. No other Federal, State, or local permits or notices are required for the planned BGA activities described in this work plan. Field work will be scheduled and coordinated with the ANG Project Manager, the local ANG Environmental Coordinator, and Seattle ANGS personnel.

A digging permit will be required by the Station to ensure that adequate precautions have been taken to protect underground utilities prior to drilling or direct-push sampling activities on Station property. This permit will be obtained prior to initiating drilling/direct-push sampling activities at the site.

SECTION 4.0

INVESTIGATIVE APPROACH

The purpose of the BGA field investigation is to further define the geologic and hydrogeologic conditions and to further evaluate the nature and extent of contamination at the Seattle ANGS. Specifically, the objectives of the field investigation are to:

- Characterize lithology and identify possible stratigraphic controls on contaminant migration in the southern portion of the Station;
- Characterize the lateral and vertical distribution of the dissolved VOC plume in the southern portion of the Station;
- Investigate potential VOC source areas in the vadose and saturated zones; and
- Evaluate temporal variability in the site hydrogeology and how these variations relate to the observed contaminant distribution.

4.1 General Approach

The field investigation will consist of the following tasks:

- Cone penetrometer testing (CPT) and discrete-depth groundwater sampling at 24 locations;
- Installation and sampling of suction lysimeters (pore water samplers) at 12 locations;
- Installation and sampling of three groundwater monitoring wells;
- Continuous water level monitoring in eight groundwater monitoring wells for 1 year; and
- A survey of sampling locations and Station topography.

The components of the BGA field program are outlined in the following subsections and are summarized in Table 4-1.

4.2 Field Investigation Activities

This section outlines the activities that will be performed during the BGA field investigation.

4.2.1 Cone Penetrometer Testing and Direct-Push Groundwater Sampling

CPT and direct-push groundwater sampling will be completed at 24 locations in the southern portion of the Station. The purpose of this task is to evaluate site lithology and identify possible stratigraphic controls on contaminant migration, characterize the vertical extent of chlorinated VOCs in groundwater, and investigate evidence for a possible VOC source in the saturated zone. The planned CPT/groundwater sampling locations are shown on Figure 4-1. At each location, CPT will be completed first followed by discrete-depth groundwater sampling in an adjacent, upgradient boring. Twelve of the CPT/groundwater borings will be completed to a depth of 30 feet bgs; the other 12 will be completed to 40 feet bgs.

Seven groundwater samples will be collected from each 30-foot boring, and eight samples will be collected from each 40-foot boring. The groundwater samples will be analyzed for VOCs at an off-site, State-certified laboratory.

4.2.2 Suction Lysimeter Installation and Sampling

Twenty-four suction lysimeters will be installed at 12 locations in the southern portion of the Station to investigate evidence for a possible VOC source or vapor-phase transport in the vadose zone. The lysimeters will be installed in pairs using hollow-stem auger, solid-stem auger, or hand auger drilling methods and will be adjacent to and upgradient of 12 of the CPT/groundwater borings (Figure 4-2). The lysimeters will be installed to approximate depths of 5 and 9 feet bgs (top of the capillary fringe), with flush-mounted surface completions.

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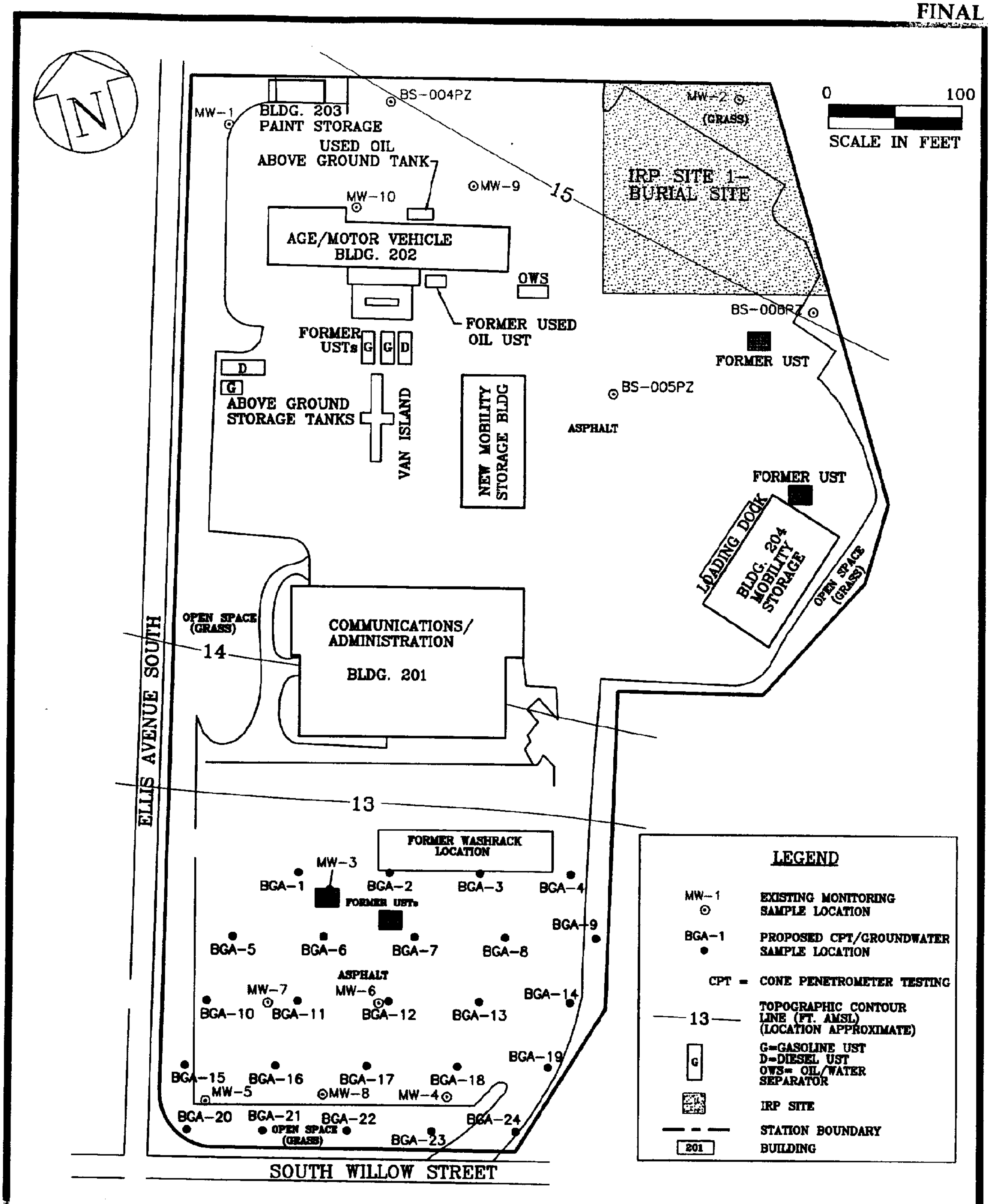
TABLE 4-1

Basewide Groundwater Assessment Field Program
143rd CCSQ, Seattle ANGS, Seattle, Washington

Sampling Location[1]	Sample Type	Estimated Number of Samples[2]	Purpose
BGA-1 through BGA-24	CPT	0[3]	Collect lithology data across the southern portion of the Station
BGA-1-*depth* through BGA-24-*depth*	Direct Push Groundwater	180 Groundwater[4]	Characterize lateral and vertical extent of VOCs in shallow groundwater
SL-1A/B through SL-12A/B	Suction Lysimeter Pore Water	24 Pore water[5]	Evaluate presence of VOCs in vadose zone soil.
MW-11 through MW-13	Groundwater	6 Groundwater[6]	Evaluate presence of VOCs in deep groundwater

Notes:

(1) See Figures 4-1 and 4-2 for sampling locations.
(2) Number of samples shown does not include field quality assurance/quality control samples.
(3) 12 CPTs will be completed to 30 feet below ground surface (bgs) and 12 CPTs will be completed to 40 feet bgs.
Only lithologic information will be collected from CPTs.
(4) Groundwater samples will be collected to total depths of either 30 or 40 feet bgs.
Groundwater samples from 30 foot bgs borings will be collected at the following approximate depths: 10, 12.5, 15, 17.5, 20, 25, and 30 feet bgs.
Groundwater samples from 40 foot bgs borings will be collected at the following approximate depths: 10, 12.5, 15, 17.5, 20, 25, 30, and 40 feet bgs.
(5) Paired suction lysimeters will be installed at approximately 5 (A) and 9 (B) feet bgs.
Samples will be collected approximately 1 week after lysimeter installation.
(6) Groundwater samples will be collected from each well immediately following development and 30 days after the initial sampling event.



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PROPOSED CONE PENETROMETER TESTING/
GROUNDWATER SAMPLE LOCATIONS

143rd CCSQ, Seattle ANGS
Seattle, Washington

FIGURE 4-1

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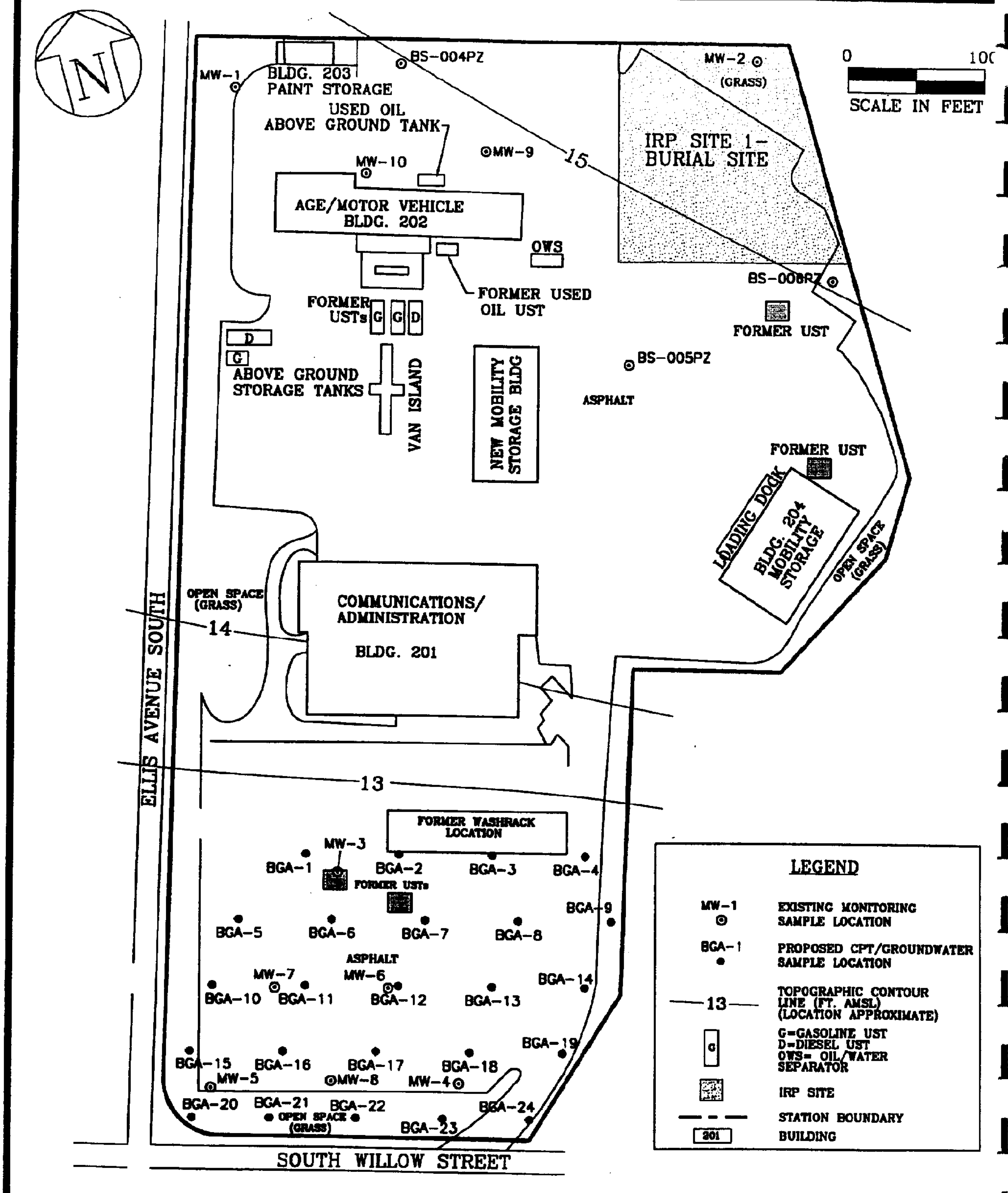
TABLE 4-1
Basewide Groundwater Assessment Field Program
143rd CCSQ, Seattle ANGS, Seattle, Washington

Sampling Location[1]	Sample Type	Estimated Number of Samples[2]	Purpose
BGA-1 through BGA-24	CPT	0[3]	Collect lithology data across the southern portion of the Station
BGA-1-*depth* through BGA-24-*depth*	Direct Push Groundwater	180 Groundwater[4]	Characterize lateral and vertical extent of VOCs in shallow groundwater
SL-1A/B through SL-12A/B	Suction Lysimeter Pore Water	24 Pore water[5]	Evaluate presence of VOCs in vadose zone soil.
MW-11 through MW-13	Groundwater	6 Groundwater[6]	Evaluate presence of VOCs in deep groundwater

Notes:
(1) See Figures 4-1 and 4-2 for sampling locations.
(2) Number of samples shown does not include field quality assurance/quality control samples.
(3) 12 CPTs will be completed to 30 feet below ground surface (bgs) and 12 CPTs will be completed to 40 feet bgs.
Only lithologic information will be collected from CPTs.
(4) Groundwater samples will be collected to total depths of either 30 or 40 feet bgs.
Groundwater samples from 30 foot bgs borings will be collected at the following approximate depths: 10, 12.5, 15, 17.5, 20, 25, and 30 feet bgs.
Groundwater samples from 40 foot bgs borings will be collected at the following approximate depths: 10, 12.5, 15, 17.5, 20, 25, 30, and 40 feet bgs.
(5) Paired suction lysimeters will be installed at approximately 5 (A) and 9 (B) feet bgs.
Samples will be collected approximately 1 week after lysimeter installation.
(6) Groundwater samples will be collected from each well immediately following development and 30 days after the initial sampling event.



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PROPOSED CONE PENETROMETER TESTING/
GROUNDWATER SAMPLE LOCATIONS

143rd CCSQ, Seattle ANGS
Seattle, Washington

FIGURE 4-1

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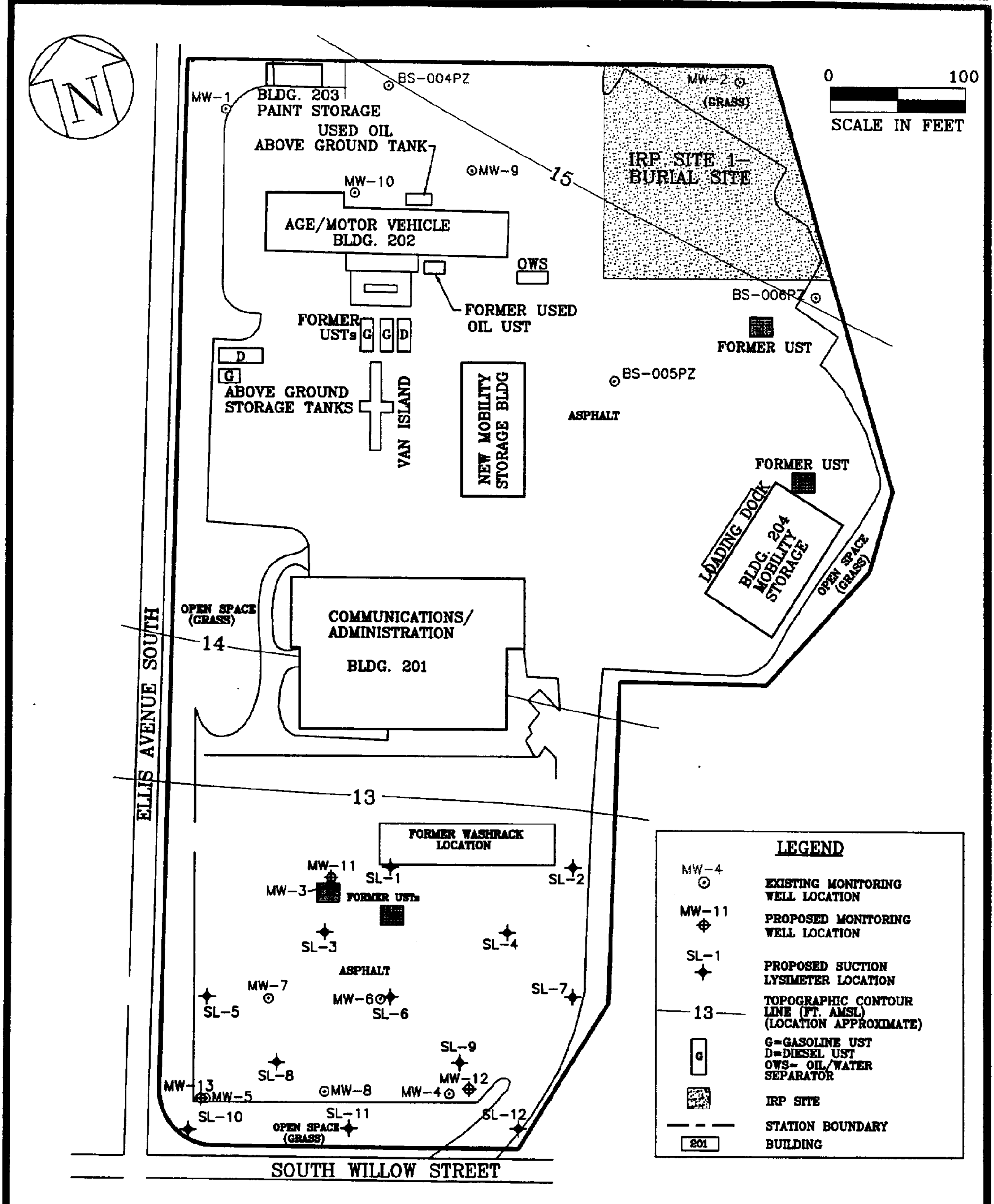

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PROPOSED SUCTION LYSIMETER AND MONITORING WELL LOCATIONS

143rd CCSQ, Seattle ANGS
Seattle, Washington

FIGURE 4-2

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One pore water sample will be collected from each lysimeter. The pore water samples will be analyzed for VOCs at an off-site, State-certified laboratory.

4.2.3 Monitoring Well Installation and Sampling

Three new groundwater monitoring wells will be installed to 40 feet bgs in the southern portion of the Station to evaluate groundwater quality and flow directions at depth. These wells will be installed adjacent to existing shallow (20-foot) wells MW-3, MW-4, and MW-5 (Figure 4-2). Each well will be installed with slotted well screen from 30 to 40 feet bgs and a flush-with-grade surface completion. The monitoring wells will be constructed similar to the monitoring wells installed during the PA/SI and RI to allow collection of comparable groundwater quality data.

Each new monitoring well will be sampled twice. One sample will be collected after the well is developed, and one sample will be collected 30 days after the initial sampling event. The groundwater samples will be analyzed for VOCs at an off-site, State-certified laboratory.

4.2.4 Water Level Monitoring

Continuous water level monitoring will be conducted in the northern and southern portions of the Station for 1 year. The purpose of this task is to investigate short- and long-term groundwater response to rainfall events, seasonal precipitation patterns, and other hydraulic inputs (i.e., groundwater recharge areas/sinks). The data will also be used to evaluate temporal variability in water table elevation and groundwater flow directions in relation to the observed contaminant distribution.

In-well pressure transducers and data loggers will be installed in three monitoring wells in the northern portion of the Station and five monitoring wells in the southern portion of the Station. The data loggers will record water levels in the monitoring wells four times per day. Every 3 months, the water level data will be downloaded for analysis. Water levels in the site monitoring wells will be measured manually.

4.2.5 Topographic Survey

The final stage of the field work will be a topographic survey of the Seattle ANGS. The survey will include surface elevation contours and site boundaries, as well as top-of-casing and ground-surface elevations of the CPT and groundwater borings, suction lysimeters, and newly installed monitoring wells. The survey will also include the surface drainage network and the location of other natural or cultural features such as roads and transportation features, water and sewer pipelines, telephone and electrical power lines, buildings, and other structures.

4.2.6 Analytical Methods

Samples collected during the BGA field investigation will be tested for VOCs in accordance with USEPA analytical protocols published in *Test Methods for Evaluating Solid Wastes (SW-846)*. The samples analyzed in the off-site laboratory will be tested using USEPA Method 8260; the samples analyzed in the mobile laboratory will be tested using USEPA Method 8260 or 8021. The number of samples to be analyzed using these methods is summarized in Table 4-2. Further details regarding quantitation limits and quality assurance/quality control (QA/QC) for laboratory analyses are discussed in the QAPP (Appendix B).

4.3 Deviations from the Work Plan

Significant deviations from the activities, procedures, or analyses performed pursuant to this work plan will be discussed and approved in advance with the ANG Project Manager. A description of such deviations will be included in the BGA Technical Memorandum.

TABLE 4-2

Basewide Groundwater Assessment Field and Laboratory Testing Plan
143rd CCSQ, Seattle ANGS, Seattle, Washington

Matrix	Sampling Method	Field Parameters	Laboratory Parameters	Analytical Method	Estimated No. Primary Sample Analyses	Estimated No. Field QA/QC Sample Analyses					Total Laboratory Analyses
						Trip Blank	Rinsate Blank	Field Blank	Field DUP	MS/MSD	
Groundwater	24 Direct Push Locations	None	VOCs	USEPA 8260	180	~~18~~ 4	18	2	18	9	245
Pore Water	24 Suction Lysimeters	None	VOCs	USEPA 8260	24	2	2	2	2	1	33
Groundwater	3 New Monitoring Wells	S.C., Turbidity, pH, Temperature, D.O., Redox	VOCs	USEPA 8260	6	2	2	2	2	1	15

Notes:
D.O. = Dissolved oxygen
DUP = Duplicate sample
MS/MSD = Matrix spike/matrix spike duplicate
MW = Monitoring well
pH = Acidity/alkalinity
QA/QC = Quality assurance/quality control
Redox = Oxidation-reduction potential
S.C. = Specific conductance
USEPA = United States Environmental Protection Agency
VOC = Volatile organic compound

SECTION 5.0

FIELD INVESTIGATION PROCEDURES

5.1 Underground Utility Clearance

Prior to the start of field work, the locations of underground utilities in the vicinity of the work area will be marked by a private utility locator service. The local public utility location service will also be notified of the need to mark underground utilities in the project area. In addition, a Station digging permit will be completed and submitted to the appropriate Station representative for approval. Planned sampling points found to interfere with buried utilities will be relocated as close as possible to the original location. The planned sampling points will be clearly marked in the field for inspection and approval by Station personnel.

5.2 Cone Penetrometer Testing and Direct-Push Ground Water Sampling

After underground utility clearance and prior to starting work, the CPT and groundwater sampling locations will be marked according to Figure 4-1 and approved in the field by Station personnel. After sampling activities are completed, the sampling points will again be clearly marked to facilitate subsequent surveying.

The CPT borings will be completed first. Vertical groundwater profiling will be performed during a subsequent mobilization; this work will consist of installing a direct-push groundwater boring upgradient of each CPT point. The following sections present the specifics of these field activities.

5.2.1 Cone Penetrometer Testing

CPT allows for rapid collection of high-quality, detailed stratigraphic and hydrogeologic data while significantly reducing site disturbance and investigation-derived waste (IDW) generation. The CPT procedure will consist of pushing a cone-tipped cylindrical probe into the ground while simultaneously measuring the resistance to penetration. The CPT probe will contain two strain-gauge load cells that measure the soil-bearing resistance acting on the conical tip of the probe and the frictional resistance along a friction sleeve. The probe will also contain a piezocone that contains a filter and a pressure transducer assembly for measuring the soil-pore fluid pressure. The measurements will be recorded in 0.05-meter increments transmitted as electric signals to a computer system within the CPT rig. The relationships of the resistance measurements can be correlated to soil types and the soil-pore fluid measurements can be related to soil saturation. Depths will be recorded by the length and number of rods used during the CPT run. Prior to each CPT run, the computer system will be zeroed at ground surface. Also, each rod will be measured prior to use to ensure the accuracy of recorded depths.

ERM will complete 24 CPT points at the Station as shown on Figure 4-1. These points will be identified as BGA-1 through BGA-24. The odd numbered locations will be completed to a total depth of 30 feet bgs and the even numbered locations will be completed to a total depth of 40 feet bgs.

ERM field personnel will maintain a bound field notebook with pertinent information observed during completion of each CPT point. Examples of pertinent information include the following:

- Location identifier;
- Total depth;
- Preliminary depth of significant lithologic changes;
- Preliminary depth of water-bearing units; and
- Obstacles encountered during CPT advancement and/or deviations from the work plan.

5.2.2 Direct-Push Groundwater Sampling

The purpose of direct-push groundwater sampling is to vertically profile the distribution of chemicals in site groundwater. Discrete-depth samples will be collected using a direct-push groundwater sampling device.

Groundwater sampling will occur after CPT is completed. The groundwater sampling locations will generally be upgradient and within 5 feet of the CPT locations, will be identified with the same location identifiers as the CPT points (BGA-1 through BGA-24), and will be completed to the same total depths. As with the CPT points, the odd numbered locations will be completed to a total depth of 30 feet bgs and the even numbered locations will be completed to a total depth of 40 feet bgs.

Groundwater samples will be collected from seven depth intervals in the 30-foot borings and eight depth intervals in the 40-foot borings. The sample intervals for the 30-foot borings will be 10, 12.5, 15, 17.5, 20, 25, and 30 feet bgs. The sample intervals for the 40-foot borings will be 10, 12.5, 15, 17.5, 20, 25, 30, and 40 feet bgs. Each sample will be labeled with the sample location followed by the maximum depth of the sample interval (e.g., BGA-1-10 for the sample collected with the bottom of the probe at 10 feet bgs in boring BGA-1). Samples will be transferred to appropriate sample containers for analysis by an off-site, State-certified laboratory in accordance with the analytical testing plan outlined on Table 4-2.

5.2.3 Borehole Abandonment

Upon completion of each CPT and groundwater boring, the borings will be abandoned either by grouting through a friction ring on the direct-push rods or filling the boreholes from the bottom up with bentonite. Grout will be mixed in the approximate ratio of one sack (94 pounds) of Portland cement to 5 pounds of powdered bentonite to 8 gallons of water. The bentonite powder and water will be mixed prior to the addition of the cement.

Following completion of the CPT and groundwater sampling activities, the site will be restored as closely as possible to its pre-investigation condition.

5.3 Suction Lysimeter Installation

After underground utility clearance and prior to starting work, the suction lysimeter locations will be marked according to Figure 4-2 and approved in the field by Station personnel. After installation, the sampling points will be clearly and permanently marked with the appropriate lysimeter identification to facilitate subsequent surveying. The following sections present the specifics of these field activities.

5.3.1 Drilling Procedures and Borehole Logging

Suction lysimeters will be installed and sampled to investigate evidence for a possible residual source of VOCs or vapor-phase transport in the vadose zone. Suction lysimeters allow for collection of in-situ soil pore water in the vadose zone and can be sampled repeatedly.

Lysimeter borings will be drilled by a State-licensed well driller. Lysimeters will be installed in pairs to depths of approximately 5 and 9 feet bgs in adjacent borings drilled using hollow-stem auger, solid-stem auger, or hand auger methods at the locations shown on Figure 4-2. The maximum boring diameter for lysimeter installation is 6 inches. The deeper lysimeter at each location will be installed within the capillary fringe based on observations made during drilling. Lysimeters will be identified as SL-1 through SL-12 with an "A" suffix (e.g., SL-1A) for the shallow lysimeter and a "B" suffix (e.g., SL-1B) for the deeper lysimeter.

An experienced geologist will be present during drilling to monitor drilling and well installation operations, conduct air monitoring with a PID, record geologic and hydrogeologic information on boring logs, and document lysimeter construction. The geologist will have sufficient tools and professional equipment in operable condition to efficiently perform these duties.

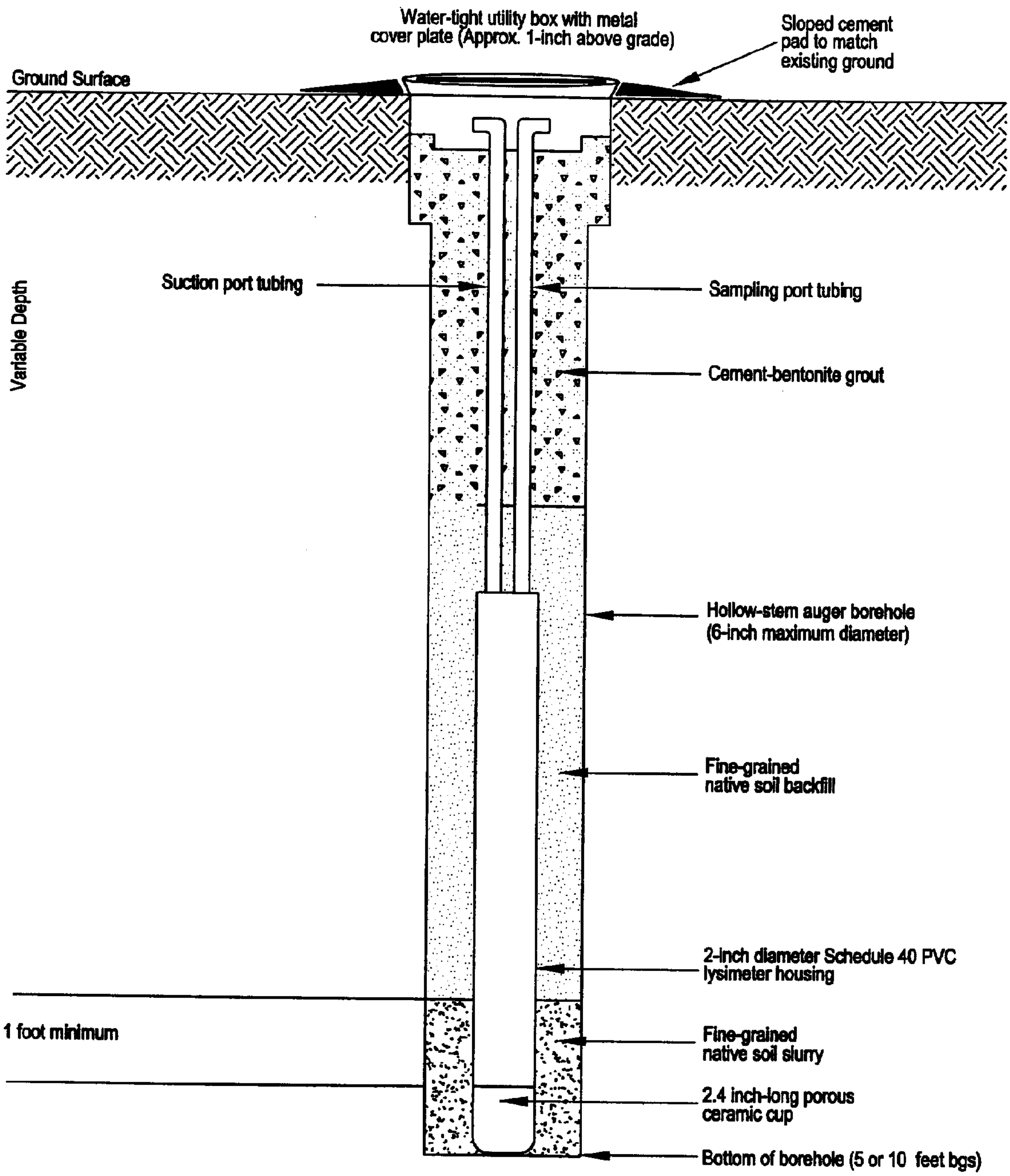
Lithologic descriptions recorded by the geologist on the boring logs will be based on visual inspection of the drill cuttings. Material will be classified using the Unified Soil Classification System and described according to ASTM D2488-69, "Description of Soils (Visual Manual Procedure)."

The following information will be recorded on the boring log for each lysimeter:

- Lysimeter identification number;
- Lysimeter location and approximate ground surface elevation;
- Name of drilling company, driller, and attendant geologist;
- Method of drilling;
- Borehole diameter;
- Air monitoring results;
- Lithologic descriptions and PID readings for soils encountered, including soil moisture/saturation conditions and corresponding drilling depths;
- Depth at which saturated soil/groundwater is first encountered while drilling, if applicable;
- Total depth of completed borehole;
- Reference elevation for depth measurements;
- Lysimeter construction details;
- Weather conditions; and
- Signature of attendant geologist.

5.3.2 Lysimeter Construction

The suction lysimeters will be constructed in accordance with applicable State well standards and requirements (Chapter 173-360 Washington Administrative Code [WAC]; Chapter 18.104 Revised Code of Washington) and with manufacturer's recommendations. Where Washington well construction regulations may be inconsistent with functional suction lysimeter construction, the manufacturer's recommendations will be followed and a variance letter will be obtained from the WDOE as necessary prior to lysimeter installation. Figure 5-1 shows the proposed construction of the lysimeters. Each lysimeter will be



ERM

PROPOSED SUCTION LYSIMETER CONSTRUCTION

143rd CCSQ, Seattle ANGS
Seattle, Washington

FIGURE 5-1

60911109.dwg, 08/09/00

completed at grade with a traffic-rated steel or aluminum monitoring well monument set in concrete. The monument will be raised slightly above the ground surface and the concrete surface seal will be sloped away from the monument to minimize collection of surface water runoff inside the monument. Each monument will be completed with enough internal space to store the lysimeter tubing without damage to the tubing.

5.3.3 Lysimeter Sampling

Vadose zone pore water samples will be collected from each lysimeter with a vacuum pump. Lysimeters typically do not require development, as do monitoring wells; however, after installation is complete and prior to sampling, a volume of water will be purged from the lysimeter equal to the amount of water used to create the soil slurry placed around the porous ceramic cup as indicated on Figure 5-1. Pore water samples will be collected using a vacuum pump and transferred to VOA vials for analysis by an off-site State-certified laboratory in accordance with the analytical testing plan outlined in Table 4-2. It is estimated that pore water samples can be collected within 1 week of lysimeter installation.

5.4 Monitoring Well Installation

Prior to the start of drilling, the locations of underground utilities in the vicinity of the planned monitoring wells will be reviewed and marked, and the monitoring wells will be relocated as necessary as described in Section 5.1.

5.4.1 Drilling Procedures and Borehole Logging

Monitoring well borings will be drilled by a State-licensed well driller. The borings will be drilled to an approximate depth of 40 feet bgs using hollow-stem auger methods. Monitoring wells will be labeled MW-11 through MW-13 to be consistent and sequential with the existing well network. An experienced geologist will be present at the drilling rig to monitor drilling and well installation operations, conduct air monitoring with a PID, record geologic and hydrogeologic information on boring logs, and document monitoring well construction. The geologist will have sufficient tools and professional equipment in operable condition to efficiently perform these duties.

Lithologic descriptions recorded by the geologist on the boring logs will be based on visual inspection of soils recovered from driving two 24-inch length split-spoon samplers for each 5 feet of depth drilled below the lowest logged interval of the adjacent monitoring well. Material will be classified using the Unified Soil Classification System and described according to ASTM D2488-69, "Description of Soils (Visual Manual Procedure)."

The following information will be recorded on the boring log for each monitoring well:

- Monitoring well identification number;
- Monitoring well location and approximate ground surface elevation;
- Name of drilling company, driller, and attendant geologist;
- Method of drilling;
- Borehole diameter;
- Air monitoring results;
- Lithologic descriptions and PID readings for soils encountered, including soil moisture/saturation conditions and corresponding drilling depths;
- Depth at which saturated soil/groundwater is first encountered while drilling;
- Total depth of completed borehole;
- Reference elevation for depth measurements;
- Monitoring well construction details;
- Weather conditions; and
- Signature of attendant geologist.

5.4.2 Monitoring Well Construction

The groundwater monitoring wells will be constructed in accordance with applicable State well standards and requirements (Chapter 173-360 Washington Administrative Code [WAC]; Chapter 18.104 Revised Code of

Washington). Figure 5-2 shows the proposed construction of the monitoring wells. The monitoring wells will be constructed of threaded, flush-joint, 2-inch Schedule 40 polyvinyl chloride (PVC) casing. The well screen will consist of 0.010-inch slotted PVC casing. The screened interval will extend from approximately 30 to 40 feet bgs.

The annular space between the well screen and the borehole wall will be backfilled with clean 10/20 silica sand installed to 1 to 2 feet above the top of the well screen. A bentonite slurry seal (2 feet minimum thickness) will be installed above the sand pack using a tremie pipe. The remaining annular space will be grouted to within 2 feet of the ground surface using a cement-bentonite mixture.

A performance test consisting of lowering a clean weighted sampling bailer to the bottom of the well will be conducted after the annular space is completely backfilled to ensure the monitoring well is straight and has not collapsed.

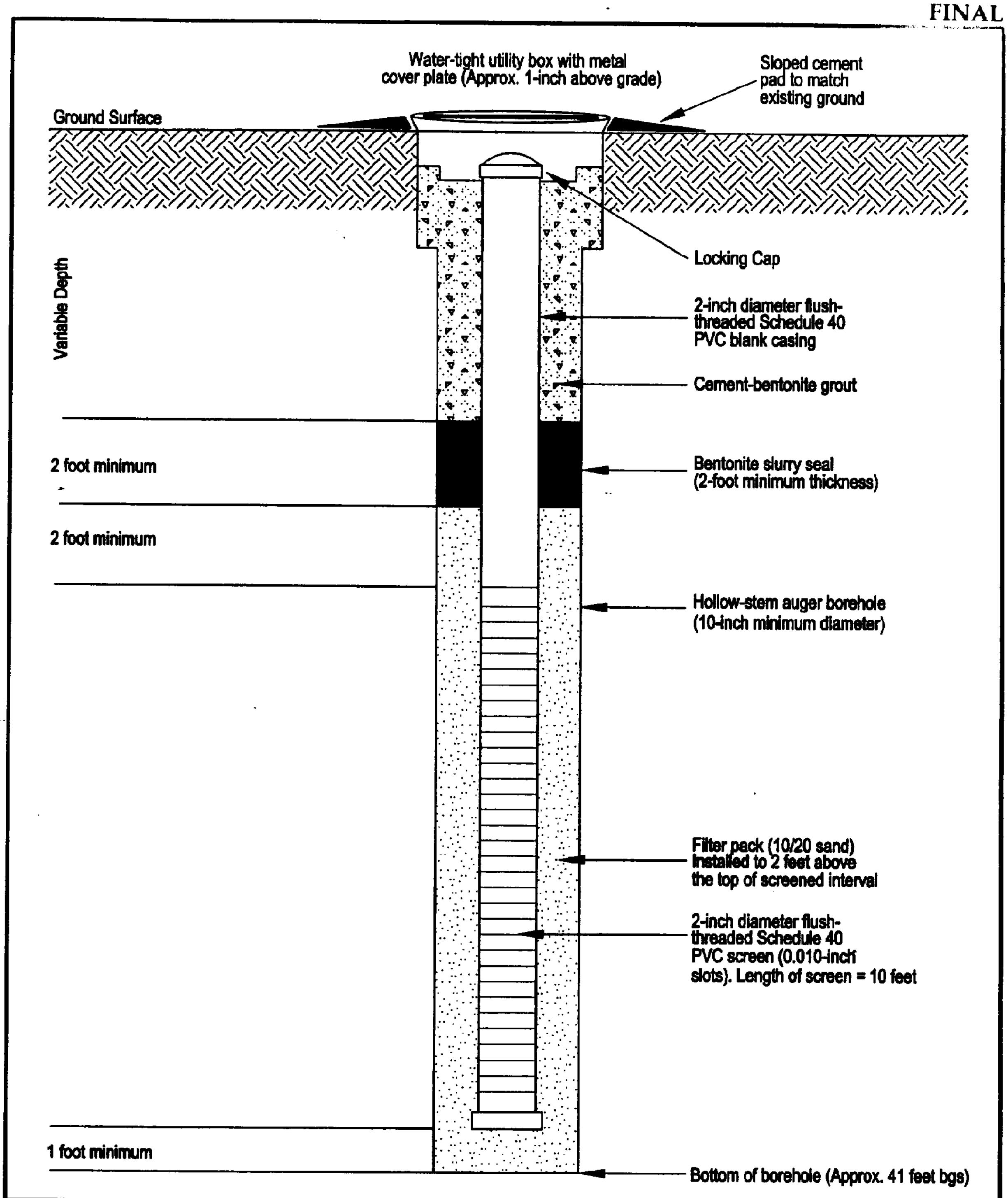
The monitoring wells will be completed at grade with a traffic-rated steel or aluminum monitoring well monument set in concrete. The monument will be raised slightly above the ground surface and the concrete surface seal will be sloped away from the monument to minimize collection of surface water runoff inside the monument. A lockable compression cap will be installed on each monitoring well inside the monument.

5.4.3 Monitoring Well Development

The monitoring wells will be developed within 24 to 48 hours after well completion. Monitoring wells will be developed using either a submersible pump or a bailer. Monitoring well development will consist of repeated well purging and surging until the clarity of the water has stabilized.

The water level in each monitoring well will be measured before development begins. An electronic water level indicator, accurate to 0.01 feet, will be used to measure the depth to water from a prescribed reference point on the well casing.

A minimum of 10 well casing volumes will be purged and at least three times the volume of any potable water added during drilling will be removed during development. The temperature, pH, turbidity, and specific conductance of the purge water will be measured during well development. Well development will continue until these parameters



ERM

PROPOSED MONITORING WELL CONSTRUCTION

143rd CCSQ, Seattle ANGS
Seattle, Washington

FIGURE 5-2

60911104.dwg, 06/23/00

have stabilized to within ±10 percent. Field logs will be maintained during well development to document specific development methods and duration, water quality parameter measurements, and the amount of water removed from each monitoring well.

5.4.4 Monitoring Well Sampling

The three new monitoring wells will be sampled immediately following development and 30 days after the initial sampling event. Groundwater samples will be collected using a submersible pump or bladder pump. Groundwater samples will be submitted to an off-site State-certified laboratory for analytical testing in accordance with the analytical testing plan outlined in Table 4-2.

5.5 Water Level Monitoring

ERM will perform continuous water level monitoring in the northern and southern ends of the Station for approximately 1 year. In-well data loggers will be installed in three northern wells and five southern wells. The data loggers will be set to record water levels every 6 hours. At the time of installation, water levels will also be measured manually with an electronic water level indicator to calibrate depths measured using the pressure transducer.

Data logger downloading and site-wide groundwater monitoring will occur on an approximate quarterly basis for 1 year. Water levels in the site wells will be measured manually during the quarterly events. Manual water levels in the eight wells with data loggers will be compared to the electronic data to confirm and, if necessary, adjust the calibration.

5.6 Equipment Decontamination Procedures

The nondedicated sampling equipment will be decontaminated prior to use and between sample collection. Per ANG decontamination protocols, sampling equipment will be washed with an aqueous solution of laboratory-grade detergent (e.g., Alconox) followed by a rinse with ASTM Type II reagent-grade water (or equivalent) and a spray rinse with isopropanol. ANG protocol calls for the use of methanol for the final spray rinse of field sampling equipment; however, the ANG has given permission for the use of isopropanol for this application on this project. In the State of Washington, spent methanol waste requires handling and disposal as a hazardous waste. Isopropanol has generally equivalent decontamination properties to methanol, but spent isopropanol is not a hazardous waste and can be disposed with the nonhazardous waste water generated during site activities. Decontaminated equipment will be wrapped in aluminum foil (shiny side outward) or otherwise stored or positioned to preclude inadvertent contamination prior to reuse.

Drilling equipment (e.g., drill bit, drill rods, and casing) will be decontaminated between borehole installations by steam cleaning in a designated decontamination area. The Site Manager is responsible for ensuring that the decontamination area is kept clean and orderly. Decontaminated equipment and unused construction materials will be removed from the site at the completion of field activities.

5.7 Documentation of Field Activities

The field geologist, and any other on-site ERM personnel performing support tasks not directly overseen by the field geologist, will maintain field notebooks during field activities. Each field notebook will be a weather-resistant, bound, survey-type field book and will be assigned a unique number. Field data generated during the investigation and comments or other notes will be entered directly into the field notebooks.

In addition to written documentation recorded in field notebooks, field activities will be documented with photographs. Activities to be photographed include CPT, groundwater sampling, suction lysimeter installation, monitoring well installation, sample collection, and equipment decontamination.

5.8 Surveying

The 24 CPT/groundwater sampling locations, the 24 lysimeters, and the three deep monitoring wells will be surveyed by a State-licensed surveyor to define their locations and surface elevations for future reference. In addition, a topographic survey of the Station will be completed. This survey will record surface elevations, the surface drainage networks and any surface water impoundments, and the location of other natural or cultural features that may influence contaminant migration. An ERM employee will oversee the survey work and be responsible for identifying all features to be surveyed. The surface elevations will be measured at horizontal intervals to allow for the development of a topographic contour map of the Station.

Surveyed points will be established with a horizontal accuracy of ±0.1 feet and a vertical accuracy of ±0.01 feet. Vertical survey data will be based on the "Boeing G" benchmark with an elevation of 10.58 feet National Geodetic Vertical Datum of 1929. The position and coordinates of each permanent point within the control traverse will be documented.

SECTION 6.0

SAMPLE COLLECTION PROCEDURES

Procedures used to collect environmental samples will follow ERM's Standard Operating Procedures for IRP program work and will conform to ANG site investigation protocols. Standard Operating Procedures are included in Appendix B of ERM's Quality Assurance Project Plan for IRP work (ERM 1995). The Site Manager is responsible for ensuring that samples are collected with properly decontaminated equipment and contained in proper sample containers with appropriate preservatives. The steps required for sample identification and control, data recording, and chain-of-custody documentation are described in the site-specific QAPP contained in Appendix B of this work plan.

6.1 Groundwater

Groundwater samples will be collected from direct-push borings, suction lysimeters, and monitoring wells. Sampling procedures for each are summarized below. Additional details regarding groundwater sampling procedures are provided in the QAPP (Appendix B).

6.1.1 Direct-Push Sampling Procedures

A direct-push sampling device will be used to collect groundwater samples from the direct-push groundwater borings. The direct-push rig will push the sampling device through the soil to the desired sampling depth. The sampling device will consist of a retractable screened rod or other device suitable for collecting groundwater samples from a discrete depth interval while minimizing the potential for cross-contamination from above. Groundwater will be collected using either a bailer or a peristaltic pump and transferred to the appropriate sample containers for analysis in accordance with the analytical testing plan outlined in Table 4-2. Equipment used during sampling will be decontaminated before use at each new sampling location as described in Section 5.6. Each vertical sampling profile will be completed within the day it is started, with the samples collected sequentially from shallowest to deepest.

6.1.2 Suction Lysimeter Sampling Procedures

Pore water samples will be collected by applying a vacuum to the lysimeter using a vacuum pump. This vacuum will be maintained by clamping the tubing. After sufficient pore water has collected in the lysimeter, pressure will be applied to the system to bring the sample to the surface for collection in appropriate sample containers. Pore water samples collected from the lysimeters will be analyzed at an off-site laboratory. Equipment used during lysimeter sampling will be decontaminated before use at each well as described in Section 5.6.

6.1.3 Monitoring Well Sampling Procedures

Groundwater samples will be collected from the three new wells both immediately following development and 30 days after the initial sampling event. Groundwater samples collected 30 days after the initial sampling event will be purged and water-level measurements taken before each well is sampled. Monitoring wells will be purged using a nondedicated submersible pump or bladder pump. Low-flow purging and sampling methods will be utilized to obtain representative groundwater samples while minimizing the amount of purge water generated.

After development or purging, groundwater samples will be collected directly from the pump discharge. Groundwater samples will be analyzed at an off-site laboratory. Equipment used during monitoring well sampling will be decontaminated before use at each well as described in Section 5.6. The pump internal parts and housing will be decontaminated by washing with the detergent solution and rinsing with ASTM Type II reagent grade water (or equivalent).

6.1.3.1 Low-Flow Well Purging

Low-flow purging and sampling methods will be used to obtain representative groundwater samples while minimizing the amount of purge water generated. The low-flow purging and sampling procedures outlined below supersede the procedures described in the QAPP. Low-flow well purging procedures to be used (as modified from Puls and Barcelona [1996] and applicable ANG protocols) are as follows:

1. A fresh piece of disposable polyethylene (or equivalent) tubing will be attached to the outlet of the decontaminated pump prior to well purging. The pump will be slowly lowered into the well to minimize the mixing of casing water and the suspension of silt at the bottom of the well. The pump will be placed near the middle or slightly above the middle of the screened interval. The pumping rate will be adjusted to approximately 100 to 500 milliliters per minute; the goal is to minimize drawdown in the well (ideally less than 10 centimeters drawdown).

   To minimize delays in field parameter stabilization and potential bias in analytical testing results, vents or other potential sources of air bubbles in the pump discharge tubing or in-line flow cell will be identified and sealed off (or otherwise isolated) prior to purging or as soon as possible after purging begins.

2. Purge water temperature, pH, specific conductance, dissolved oxygen, oxidation-reduction (redox) potential, and turbidity will be monitored using an in-line flow cell. At a minimum, readings will be taken and recorded every 3 to 5 minutes.

3. Purging will be suspended when the following parameters have stabilized for three successive readings or when at least one well casing volume has been purged:

   - Temperature: ± 1 degree Celsius;
   - pH: ± 0.1 units;
   - Specific conductance: ± 10 percent; and
   - Dissolved oxygen or turbidity: ± 10 percent.

4. After well-purging criteria are satisfied, the in-line flow cell will be disconnected and groundwater samples will be collected in the 40-millimeter VOA vials.

5. The pump will be removed from the well, disposable tubing will be discarded, and the pump will be decontaminated as described above.

6.1.3.2 Sampling of Low-Yield Wells

When purging and sampling wells with relatively low yield rates, if continuous flow is not sustainable during well purging, the pump will be turned off and the well will be allowed to recover for a period not longer than 24 hours. After the water level in the well has recovered, the required samples will be collected with the pump placed near the middle of the screened interval.

6.2 Field Quality Assurance/Quality Control Samples

Field duplicate samples and equipment rinsate blanks, field blanks, and trip blanks will be submitted to the analytical laboratory to provide a means of assessing the data quality resulting from the field sampling program. Field duplicate samples will be analyzed to assess sample homogeneity. Rinsate, field, and trip blanks will be analyzed to check for potential contamination associated with sampling procedures, ambient conditions at the site, and/or sample packaging and transportation methods.

The estimated number and types of field QA/QC samples to be collected during the BGA are summarized in Table 4-2. Additional details regarding field QA/QC procedures are provided in the QAPP (Appendix B).

SECTION 7.0

INVESTIGATION-DERIVED WASTE MANAGEMENT

Drill cuttings, purge water, and decontamination water generated during drilling and sampling activities will be contained in segregated 55-gallon drums. The IDW drums will be clearly marked with a description of the contents and the accumulation date. The contents of each IDW drum will be designated as hazardous/dangerous waste or nonhazardous/ nondangerous waste in accordance with Federal Resource Conservation and Recovery Act (RCRA) and Washington State Dangerous Waste Regulations. The waste designation will be based on the analytical results for samples collected during the BGA.

Purge and decontamination water determined to be nonhazardous/ nondangerous may be discharged to the sanitary sewer after obtaining approval from the local Publicly Owned Treatment Works or removed for off-site disposal by a licensed contractor. Drill cuttings determined to be nonhazardous/nondangerous may be removed for off-site disposal by a licensed contractor.

Disposal of IDW determined to be hazardous or dangerous waste is not included in the scope of this project. However, ERM will be responsible for waste characterization, container labeling, manifest preparation, and recommendation of applicable and appropriate disposal or treatment methods for hazardous/dangerous wastes generated during the BGA. The Seattle ANGS is ultimately responsible for disposal of IDW.

SECTION 8.0

PROJECT SCHEDULE AND DELIVERABLES

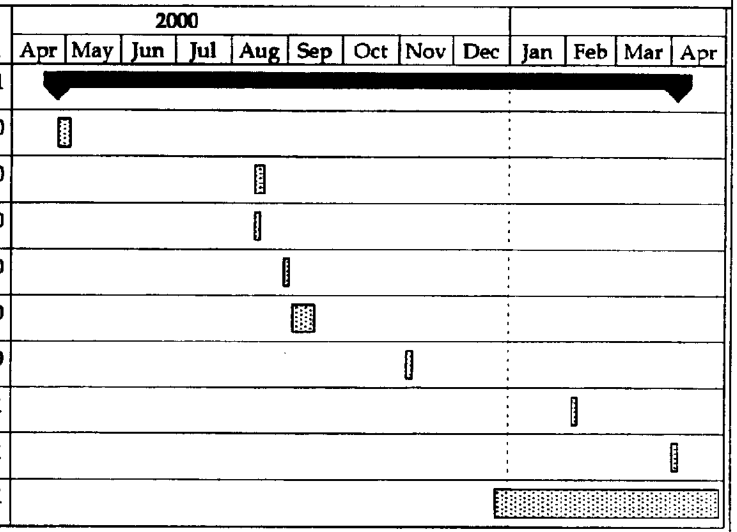
A project schedule is shown in Figure 8-1. Subsurface investigation work (i.e., CPT, well/lysimeter installation, direct-push groundwater sampling) is expected to be conducted in August and September 2000; water level monitoring will be performed from May 2000 to April 2001. A technical memorandum summarizing the BGA findings will be submitted at the end of the project; a sample outline for this memorandum is contained in Appendix C.

FIGURE 8-1

Seattle ANGS Basewide Groundwater Assessment Schedule
143rd CCSQ, Seattle ANGS, Seattle, Washington

Seattle ANGS Basewide Groundwater Assessment

ID	Task Name	Duration	Estimated Start	Estimated Finish
1	**Field Investigation**	246d	Thu 4/27/00	Wed 4/4/01
2	Data Logger Installation	5d	Thu 4/27/00	Wed 5/3/00
3	Cone Penetrometer Testing	5d	Mon 8/14/00	Fri 8/18/00
4	Data Logger Download	3d	Mon 8/14/00	Wed 8/16/00
5	Well and Lysimeter Installation	3d	Wed 8/30/00	Fri 9/1/00
6	Pore Water and Groundwater Sampling	10d	Mon 9/4/00	Fri 9/15/00
7	Data Logger Download	3d	Mon 11/6/00	Wed 11/8/00
8	Data Logger Download	3d	Mon 2/5/01	Wed 2/7/01
9	Data Logger Download	3d	Mon 4/2/01	Wed 4/4/01
10	**Prepare BGA Technical Memorandum**	90d	Mon 12/25/00	Fri 4/27/01



Date: Tue 8/8/00 | Subtask | Summary Task

Figure 8-1.MPP

SECTION 9.0

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Appendix A

APPENDIX A

SITEWIDE SAFETY AND HEALTH PLAN

EMERGENCY REFERENCES

Key Telephone Numbers

AMBULANCE	911
POLICE	911
FIRE	911
HOSPITAL	911
NATIONAL RESPONSE CENTER	1-800-424-8802
POISON CONTROL CENTER	1-800-682-9211
TOXLINE	1-301-496-1131
CHEMTREC	1-800-424-9300
ERM, WALNUT CREEK OFFICE	1-510-946-0455
ERM, BELLEVUE OFFICE	425-462-8591
BASE SAFETY REPRESENTATIVE	MSgt Tim Wise 206-767-1532
BASE ENVIRONMENTAL COORDINATOR	Steven Purvine 1-253-512-3205

Nearest Hospital

Harborview Medical Center 325 Ninth Avenue Seattle, Washington	1-206-223-3074

Directions to Hospital (See Figure A-1)

Exit the Seattle ANGS through the main entrance. Turn right (north) onto Ellis Avenue. In one block, turn left (west) onto Warsaw Street. In one block, turn north onto Corson Avenue, and follow signed lanes to Interstate 5. Enter Interstate 5 Northbound. Exit Interstate 5 at the James Street Exit (Exit 164) and exit the collector/distributor on the James Street off-ramp. Turn right (east) on James Street, follow 2 blocks to 9th Avenue. Turn right on to 9th Avenue, Harborview Hospital is on the right.

ERM Representatives

PROJECT MANAGER	Robert Leet
SITE MANAGER	TBN
SITE HEALTH AND SAFETY OFFICER	TBN
DIRECTOR, HEALTH AND SAFETY	Steven Meyers, C.S.P., C.I.H.

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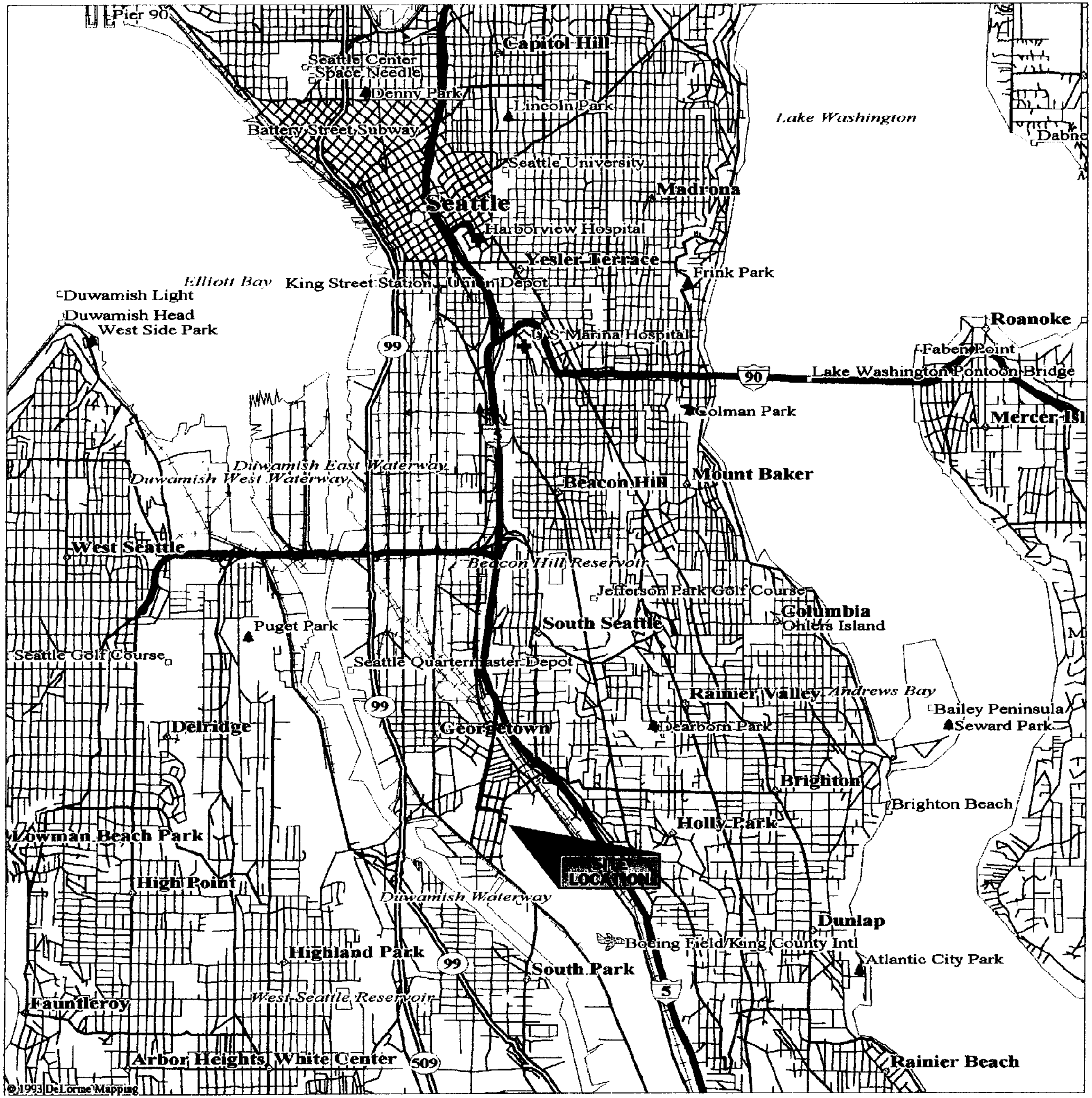

Scale 1:62,500 (at center)

1 Miles

2 KM

LEGEND

- State Route
- Geo Feature
- Major City
- Town, Small City
- Hospital
- Park
- Interstate, Turnpike
- Population Center
- Street, Road
- Hwy Ramp
- Major Street/Road
- Street, Road
- Interstate Highway
- State Route
- Railroad
- River
- Land Mass
- Open Water

Route to Hospital

FIGURE A-1
Map to Hospital

EMERGENCY RESPONSE PLAN SUMMARY

In the event of a health or safety emergency at the site, appropriate emergency measures will immediately be taken to assist those who have been injured or exposed and to protect others from hazards. The Site Safety and Health Officer will be immediately notified and will respond according to the seriousness of the injury. Personnel trained in first aid will be present during site activities to provide appropriate treatment of injuries or illnesses incurred during field operations. The ERM Project Manager and Site Manager shall be immediately informed of any serious injuries.

Additional emergency response and accident investigation procedures are detailed in Section 7.0 of this Safety and Health Plan.

General Evacuation Plan

In case of fire, explosion, or toxic vapor release, a site evacuation may be ordered by the Site Safety and Health Officer. The following procedure shall be followed in the event of an evacuation:

- Announce the evacuation via radio/horn and notify ANG personnel and others in site buildings, then immediately call 911;
- Evaluate the immediate situation and downwind direction. All personnel will evacuate in the upwind direction;
- All personnel will assemble in an upwind area when the situation permits, and a head count will be taken by the Site Safety and Health Officer; and
- Await the arrival of local qualified emergency response personnel.

First Aid

Qualified personnel on site shall give first aid and stabilize any worker needing assistance. Professional medical assistance shall be obtained at the earliest possible opportunity. If assistance beyond first aid is required, call 911 and request emergency medical assistance.

A first-aid kit and emergency 16-ounce eyewash station shall be maintained readily accessible to all workers. The 16-ounce eyewash station should be supplemented by a nearby 15-minute eyewash station.

Emergency first aid for organic hazardous substances is outlined in Section 7.4 of this Safety and Health Plan.

Spills or Hazardous Material Releases

Spills or hazardous material releases that pose a potential threat to human health or the environment shall be reported to the appropriate authorities, including the Base Environmental Coordinator Stephen Purvine at (253) 512-3205, by the Site Safety and Health Officer. Small spills that do not pose a threat shall be reported to the Site Safety and Health Officer and will be addressed per the chemical manufactures' recommended procedures.

In the unlikely event of a significant release of hazardous material during field work, the proper state and local authorities will be immediately notified. Appropriate actions will be taken to protect the public and control the continued release or migration of the hazardous material.

Emergency Operation Shutdown Procedures

In the event a hazardous situation develops on site, the Site Safety and Health Officer may temporarily suspend operations until the situation is corrected or controlled. The Site Safety and Health Officer will have the authority to restart operations when the situation as been corrected and safe working conditions have been restored.

DISCLAIMERS AND LIMITATIONS ON USE

Environmental Resources Management ("ERM") developed the following Sitewide Safety and Health Plan (the "SSHP") for use by ERM personnel and by ERM subcontractors (individually, an "ERM Contractor" and collectively, "ERM Contractors") in connection with soil and groundwater investigation, monitoring, and remediation activities (the "Project") being performed by ERM for the Air National Guard Readiness Center (the "Client") at the Seattle Air National Guard Station in Seattle, Washington (the "Site"). ERM personnel must adhere to the practices and procedures specified in the SSHP.

Each ERM Contractor must review the SSHP and agree to accept and abide by the SSHP, subject to any modifications to the SSHP (to address the ERM Contractor's more stringent practices and procedures) agreed upon in writing by ERM and the ERM Contractor. The ERM Contractor shall indicate such acceptance by executing a copy of this notice of disclaimers and limitations on use as indicated below and returning it to ERM's project manager for the Project prior to commencing work at the Site. However, if any ERM Contractor commences work at the Site, the ERM Contractor shall be deemed to have accepted the SSHP and the terms hereof and the failure to execute and return to ERM a copy of this notice shall not be relevant to such interpretation.

If a contractor or a person other than the Client, ERM employees and ERM Contractors (individually, a "Third Party" and collectively, "Third Parties") receives a copy of the SSHP, such Third Party should not assume that the SSHP is appropriate for the activities being conducted by the Third Party. NO THIRD PARTY HAS THE RIGHT TO RELY ON THE SSHP. EACH THIRD PARTY SHOULD ABIDE BY ITS OWN SSHP IN ACCORDANCE WITH ITS OWN PROFESSIONAL JUDGMENT AND ESTABLISHED PRACTICES.

ERM shall not be responsible for the implementation of any Third Party's safety program(s), except to the extent otherwise expressly agreed upon by ERM and a Third Party in writing. The services performed by ERM for the Client and any right of the Client and/or an ERM Contractor to rely on the SSHP shall in no way inure to the benefit of any Third Party, including, but not limited to, employees, agents, or consultants and subcontractors of ERM Contractors, so as to give rise to any cause of action by such Third Party against ERM.

The SSHP generated by ERM in connection with the Project is for use on a specific site and in connection with a specific project. ERM makes no representation or warranty as to the suitability of the SSHP for reuse on another site or as to the suitability of the SSHP for reuse on another project or for modifications made by the Client or a Third Party to the SSHP.

ERM Contractors Only

Agreed and Accepted:

Contractor's Name: ______________________________

By: ______________________________

Title: ______________________________

Date: ______________________________

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SECTION 1.0

INTRODUCTION

This Sitewide Safety and Health Plan (SSHP) has been developed by Environmental Resources Management (ERM) to establish the safety and health procedures required to minimize potential hazards to personnel who will be involved in soil and groundwater investigation, monitoring, and remediation activities planned for the Seattle Air National Guard Station (Seattle ANGS) in Seattle, Washington. The provisions of this SSHP directly apply to ERM personnel and contractors, if utilized, who will be potentially exposed to safety and/or health hazards related to the project. This SSHP does not directly apply to Air National Guard (ANG) personnel, although ERM will advise ANG personnel on the safety and health aspects of the work based upon the guidelines specified in this SSHP.

The procedures in this SSHP have been developed based upon current knowledge regarding the specific chemical and physical hazards that are known or anticipated for the operations to be conducted at the Station. This SSHP has been written to comply with the requirements of ERM safety and health policies. It is ERM's policy that activities covered by this SSHP must be conducted in complete compliance with this SSHP and with all applicable federal, state, and local safety and health regulations, including the federal Occupational Safety and Health Administration (OSHA) Construction Industry Standards in 29 Code of Federal Regulations (CFR) 1910.120. On-site personnel who cannot, or will not, comply with these requirements will be excluded from project activities. Prior to the commencement of field activities, all ERM and subcontractor personnel covered by this SSHP must review this document and return the sign-off form to the Site Manager.

1.1 Site Description and History

This section discusses the general history and physiography of the Seattle ANGS in Seattle, Washington. Site location and land use are described, hazardous chemicals associated with site activities and known releases are identified, and general site characteristics are presented.

1.1.1 Location

The Seattle ANGS is located in the northwest corner of King County International Airport (also known as Boeing Field), in Seattle, Washington. The Seattle ANGS, which is the headquarters for the 143rd Combat Communications Squadron (CCSQ), is located at 6736 Ellis Avenue South and currently occupies 7.5 acres. Boeing Field is located approximately 3 miles south of the Seattle central business district. Land use in the vicinity of the Seattle ANGS is industrial, residential, and commercial.

1.1.2 Operations History

Seattle ANGS was built during World War II by the War Department and was used by the Army Air Force as the "Aircraft Factory School" during the war. In 1948, the property was transferred to King County as surplus property and was subsequently leased to the Washington ANG.

On 21 April 1948, the 143rd Aircraft Control and Warning Squadron was established. From May 1951 to February 1953, the 143rd was activated for recruitment purposes. During this period of time, the unit has two C-47 aircraft. In 1960, the name of the unit was formally changed to the 143rd communication Squadron Tributary Teams. In 1969 and 1988, the name of the unit was again changed, becoming the 143rd Mobile Communications Squadron and the 143rd CCSQ, respectively. The current mission of the 143rd CCSQ is to provide mobile communication equipment and support for airports and airfields.

In 1948, the Seattle ANGS consisted of 17 acres of land, including an aircraft parking ramp, leased from King County. At that time, the property contained 15 buildings (including a number of small shed structures), all of which were subsequently demolished. In 1951, a new property lease decreased the size of the ANGS from 17 acres to its present size of 7.5 acres, and buildings were constructed for headquarters, mess hall, warehouse, and vehicle service requirements.

In 1980, the National Guard Bureau and Congress funded $2.3 million for the replacement of all buildings at the Seattle ANGS. The buildings were completed in 1984, with the exception of the Mobility Warehouse, which was completed in 1988. Seattle ANGS now consists of 7.5 acres and four buildings with a total area of 34,698 square feet. The Seattle ANGS property is leased from King County by the U.S. Air Force, who in turn licenses the property to the Washington State Military Department for Air National Guard use.

The operations of the 143rd CCSQ include ground vehicle maintenance; electrical maintenance; and petroleum, oil, and lubricants (POL) distribution and management. Significant quantities of gasoline, diesel fuel, and engine oil are used on the Seattle ANGS, as are smaller amounts of industrial solvents, antifreeze, paints, and acids. Typical wastes include contaminated fuels, spent solvents, off-specification materials, and refrigeration oils.

1.2 Prior Investigations

1.2.1 Preliminary Assessment and Site Inspection

A Preliminary Assessment/Site Inspection (PA/SI) was completed by Operational Technologies Corporation (OpTech) between 1991 and 1995. OpTech completed a geophysical survey, soil gas survey, and three soil borings, and installed a total of 3 groundwater monitoring wells in the Burial Site Area of Concern (AOC) at the Seattle ANGS. The geophysical survey was completed using ground-penetrating radar (GPR) and magnetometer methods to detect possible buried waste materials or containers in the AOC.

Beryllium and total petroleum hydrocarbons (TPH) were detected at concentrations greater than Model Toxics Control Act (MTCA) cleanup levels in soil samples collected by OpTech from the soil borings at the Burial Site AOC. Beryllium was detected at a maximum concentration of 1.1 milligrams per kilogram (mg/kg). TPH was detected at a maximum concentration of 780 mg/kg. Gross alpha and gross beta analyses of soil samples indicated particle activities from 0 to 4 picoCuries per gram (pCi/g).

Arsenic, beryllium, chromium, and lead were detected at concentrations greater than MTCA cleanup levels in groundwater samples collected by OpTech from the monitoring wells at the Burial Site AOC. The maximum concentrations detected in the groundwater samples were as follows: arsenic - 28 micrograms per liter (μg/l), beryllium - 820 μg/l, chromium - 97 μg/l, and lead - 26 μg/l. Gross alpha and gross beta analyses of groundwater samples indicated particle activities from 15 to 77 picoCuries per liter (pCi/l). The MTCA method A cleanup level for gross alpha activity is 15.0 pC/l.

1.2.2 Remedial Investigation

During the Remedial Investigation (RI) and groundwater monitoring, the results of the soil and groundwater chemical analyses were compared to project screening goals (PSGs) developed for the Station. Based on this comparison, contaminants of concern (COCs) were identified at the site.

COCs identified at the Seattle ANGS include:

Soil - None

Groundwater

- Trichloroethene (TCE)
- Tetrachloroethylene (PCE)

The distribution of volatile organic compounds (VOCs) detected in groundwater at the Station does not display any clear pattern to suggest possible on-site source(s) of the VOCs.

1.3 Investigation Work Plan

The Basewide Groundwater Assessment (BGA) will consist of vertical lithologic profiling and discrete-depth groundwater sampling at 24 locations in the southern portion of the Seattle ANGS. Vadose zone pore water sampling at 12 locations will also be performed. Three 40-foot-deep groundwater monitoring wells will be installed and sampled to evaluate dissolved VOC concentrations, groundwater flow directions, and vertical hydraulic gradients.

Details regarding the activities to be conducted during the BGA are discussed in the BGA Work Plan.

SECTION 2.0

KEY PERSONNEL

The organization and responsibilities for implementing safe project activities, and more specifically the requirements contained in this SSHP, are discussed in this section.

The key personnel for this project are:

• Project Manager	Robert Leet
• Site Manager	TBN
• Site Safety and Health Officer	TBN
• Director of Internal Safety and Health	Steven Meyers, CIH

2.1 Project and Site Manager

The ERM Project Manager is, by designation, the individual who has the primary responsibility for ensuring the overall safety and health of this project. The Site Manager has the primary responsibility for ensuring the SSHP is implemented in the field. The Site Manager's specific responsibilities include:

- Ensuring that all site project personnel have received a copy of and have read this SSHP and have completed the SSHP signature sheet;
- Requiring the attendance of all site personnel to a daily tailgate briefing apprising them of the contents of this SSHP and the specific hazards present at the facility prior to performing work;
- Ensuring that sufficient personal protective equipment (PPE), as required by this SSHP, is available during the project;
- Obtaining all subcontractor documentation of employee participation in a medical monitoring and health and safety training program;

- Maintaining a high level of safety and health consciousness among employees at the facility; and
- Maintaining regular communications with the Site Safety and Health Officer (SHO), the Project Manager, and, if necessary to resolve safety and health conflicts, the Director of Internal Safety and Health (DISH).

2.2 Site Safety and Health Officer

The appointed SHO will be a member of the ERM project field team. The SHO responsibilities include enforcing the requirements of this SSHP once work begins. By design, the SHO has the authority to immediately correct all situations where noncompliance with this SSHP is noted and to immediately stop work in cases where an immediate danger is perceived. The SHO's specific responsibilities include:

- Procuring and distributing the PPE and air monitoring instrumentation needed for the project;
- Verifying that all PPE and safety and health equipment is in good working order;
- Setting up and maintaining the personnel decontamination facility;
- Controlling site entry of unauthorized personnel;
- Supervising and monitoring the safety performance of all personnel to ensure that required safety and health procedures are followed, and correcting any deficiencies;
- Conducting accident/incident investigations and preparing investigation reports; and
- Initiating emergency response procedures.

2.3 Director of Internal Safety and Health

ERM's DISH is the individual responsible for the preparation, interpretation, and modification of this SSHP. Modifications to this SSHP which may result in less stringent precautions cannot be undertaken by the Project Manager, Site Manager, or SHO without the approval of the DISH. Specific responsibilities of the DISH include:

- Advising the Project Manager, Site Manager, and SHO on matters relating to safety and health on this project;

- Recommending appropriate PPE and air monitoring instrumentation to protect personnel from potential hazards present on site;

- Performing field audits, when necessary, to monitor the effectiveness of the SSHP and to ensure compliance with it;

- Conducting or directing personal exposure monitoring where required and where deemed necessary to determine the adequacy of protective measures and PPE specified by this SSHP;

- Maintaining contact with the Project Manager to regularly evaluate project conditions and new information which might require modification to this SSHP;

- Working with the Site Manager to ensure that sufficient PPE is available at the site; and

- Conducting briefing meetings, when necessary, to apprise personnel of the contents of this SSHP and the project hazards.

2.4 Field Personnel

All field and subcontractor personnel are responsible for following the safety and health procedures specified in this SSHP and for performing their work in a safe and responsible manner. Specific requirements include:

- Obtaining a copy of this SSHP and reading it, in its entirety, prior to the start of field activities;

- Signing the Safety and Health Signature Sheet acknowledging receipt and understanding of this SSHP;

- Bringing forth any questions or concerns regarding the content of the SSHP to the SHO, Site Manager, Project Manager, or DISH prior to the start of work;

- Reporting accidents/incidents and the presence of potentially hazardous working situations to the SHO and Site Manager; and

- Complying with the requests of the appointed SHO.

SECTION 3.0

PARTICIPANT QUALIFICATIONS

3.1 Training Requirements

All ERM field personnel working on the Seattle ANGS RI and Feasibility Study (FS) activities will have completed a 40-hour OSHA training course in Hazardous Waste Operations and Emergency Response (HAZWOPER), and will have previously worked at least 3 days at a hazardous waste site. The 40-hour OSHA training course must be designed to meet the requirements of 29 CFR 1920.120. In addition, field personnel who completed their 40-hour HAZWOPER training more than 1 year prior to the start of field activities will have completed an annual 8-hour refresher course.

All subcontractor personnel will be required to show proof of current OSHA HAZWOPER training (less than 1 year since initial or refresher training) prior to field activities. Personnel without current training documentation will be barred from site activities.

3.2 Medical Surveillance

All site workers will be required to have a written statement from a licensed physician stating they have had a medical examination which meets the requirements of 29 CFR 1910.120. This examination must include pulmonary function testing as well as certification by the physician of the employee's ability to wear a negative-pressure respirator and perform strenuous work. If a person sustains an injury or contracts an illness related to work on site that results in lost work time, he/she must obtain written approval from a physician to regain access to the site.

3.3 Record Keeping

Air monitoring via industrial hygiene monitoring or direct-reading instruments will become part of the written record. Medical and air monitoring data will be retained for 30 years. Training records will be maintained in project files and will be available for inspection at any time. Subcontractor training and medical surveillance certification will also be maintained in project files.

SECTION 4.0

HAZARD EVALUATION

4.1 Chemical Hazards

Based on data collected from soil and groundwater sampling at the site during the RI and groundwater monitoring, the suspected chemical hazards at the Seattle ANGS consist of chlorinated VOCs (primarily TCE) in groundwater. Hazards of these chlorinated VOCs are discussed below.

4.1.1 Volatile Organic Compounds

Most VOCs, except those known to be carcinogenic, exhibit similar health effects in humans. Effects on the central nervous and upper respiratory systems and skin irritation predominate. Therefore, although the hazards of several common VOCs are described separately below, the potential additive effects of multiple compounds were considered in determining air monitoring action levels.

Trichloroethene. TCE is a colorless, low-flammability liquid with a chloroform-like odor. It is toxic to the central nervous system and is also a carcinogen. Inhalation of TCE can cause narcosis, headache, drowsiness, hallucinations, and distorted perception. At high concentrations, inhalation can cause unconsciousness or death due to cardiac arrest. TCE vapor is irritating to the eyes, nose, respiratory tract, and skin. Chronic exposure may cause heart, liver, and kidney damage. The current OSHA and Washington State Time-Weighted Average (TWA) Permissible Exposure Limit (PEL) for TCE vapor is 50 parts per million (ppm). The short term (15-minute) exposure limit (STEL) is 200 ppm.

Tetrachloroethene. PCE is a colorless, non-combustible liquid with a mild, chloroform-like odor. It is toxic to the central nervous system and is also a carcinogen. Exposure to PCE can adversely effect functioning of the mucous membranes, eyes, lungs, liver, kidney, and heart. Common symptoms of exposure include dizziness, headache, light-headedness, and possibly unconsciousness. Skin contact may cause a dry, scaly, itchy dermatitis. Recent studies suggest that PCE can cause liver cancer in rats and mice. The current OSHA and Washington State TWA PEL for PCE vapor is 25 ppm.

__1,2-Dichloroethene (1,2-DCE).__ 1,2-DCE is a colorless, flammable liquid with a slightly acrid, chloroform-like odor. It is toxic to the central nervous system and is also a suspected human carcinogen. 1,2-DCE vapor is irritating to the eyes, nose, and respiratory tract. At high concentrations, it has caused liver and kidney damage in laboratory animals. The current OSHA TWA PEL for 1,2-DCE vapor is 200 ppm.

Table 4-1 provides a summary of the exposure information for the compounds identified above, as well as several other hazardous substances commonly found at contaminated sites.

4.2 Physical Hazards

Physical hazards associated with site activities include slips, trips, falls, contact and crushing type injuries, eye abrasions, contusions, lacerations, flammability, and heat stress concerns. The potential for such hazards necessitates the use of safety shoes or boots, eye goggles or safety glasses, and hard hats. Additionally, personnel engaged in work activities with the potential for hand or finger injuries are to wear sturdy work gloves.

4.2.1 Use of Equipment

Any equipment, including vehicles, winches, or other machinery will be operated in strict compliance with the manufacturer's instructions, specifications, and limitations as well as any applicable regulations. The operator is responsible for inspecting the equipment daily to ensure that it is functioning properly and safely. This inspection will include all pins, pulleys, and connections subject to accelerated wear and all lubrication points.

When equipment with moving booms, arms, or masts are operated in the vicinity of overhead hazards, the operator, with assistance from the designated signaling person, will ensure that the moving parts of the equipment maintain safe clearances to the hazards. Equipment will be kept at least 20 feet away from energized electrical lines.

TABLE 4-1

Exposure Information for Selected Potential Site Compounds
143rd CCSQ, Seattle ANGS, Seattle, Washington

Compound	OSHA PEL/WA PEL/STEL (ppm)	Physical Description	Routes of Exposure	Symptoms of Exposure	Air Monitoring Instrument
Gasoline	None/300/500	Clear to amber liquid with an aromatic odor.	Inh, Ing, Con	CNS depression; eye, nose, and throat irritation.	PID/FID
Diesel	None	Red-amber liquid, fuel odor.	Inh, Ing, Con	CNS depression; eye irritation.	PID/FID
Heavy Oils	None	Dark brown or black liquid, petroleum odor.	Ing, Con	Skin irritation.	PID/FID, Visual
Benzene	1/1/5	Colorless liquid with an aromatic odor.	Inh, Abs, Ing, Con	Skin, eye, nose, and throat irritation; dermatitis.	PID/FID
Toluene	100/100/150	Colorless liquid with a sweet, pungent, benzene-like odor.	Inh, Abs, Ing, Con	CNS depression; dilated pupils, nervousness, fatigue.	PID/FID
Ethylbenzene	100/None/125	Colorless liquid with a chloroform-like odor.	Inh, Ing, Con	CNS depression; eye, nose, and throat irritation.	PID/FID
Xylene	100/100/150	Colorless liquid with an aromatic odor.	Inh, Abs, Ing, Con	CNS depression; skin, eye, nose, and throat irritation; nausea, vomiting.	PID/FID

TABLE 4-1 (cont.)

Exposure Information for Selected Potential Site Compounds
143rd CCSQ, Seattle ANGS, Seattle, Washington

Compound	OSHA PEL/WA PEL/STEL (ppm)	Physical Description	Routes of Exposure	Symptoms of Exposure	Air Monitoring Instrument
TCE	50/50/200	Colorless liquid with a chloroform-like odor. Sometimes dyed blue.	Inh, Abs, Ing, Con	Headache, vertigo; visual distortion, tremors, nausea, vomiting; eye and skin irritation; cardiac arrhythmia.	PID/FID
PCE	25/25/None	Colorless liquid with a mild, chloroform-like odor.	Inh, Ing, Con	Eye, nose, and throat irritation; nausea; flushed face and neck; vertigo, dizziness, incoherence; headache.	PID/FID
1,2-DCE	200/None/None	Colorless liquid with a slightly acrid, chloroform-like odor.	Inh, Ing, Con	CNS depression; eye and respiratory system irritation.	PID/FID
Methylene Chloride	500/25/None	Colorless liquid with a chloroform-like odor.	Inh, Ing, Con	Fatigue, weakness, sleepiness, lightheadedness; numbness or tingling of limbs; nausea; eye and skin irritation.	PID/FID

ppm = Parts per million
Inh = Inhalation
Ing = Ingestion
Con = Skin and/or eye contact
Abs = Skin absorption
PID = Photoionization detector
FID = Flame ionization detector

OSHA = Occupational Safety and Health Administration
PEL = Permissible Exposure limit
STEL = Short Term Exposure Limit
WA = Washington
TCE = Trichloroethylene
PCE = Tetrachloroethylene
DCE = Dichloroethylene

All portable equipment and tools will be inspected prior to each day's use and as often as necessary to ensure that it is safe to use. Defective equipment and tools will be removed from service immediately. Examples of defective tools include: hooks and chains stretched beyond allowable deformations; cables and ropes with more than the allowable number of broken strands; missing grounding prongs on power tools; defective on/off switches; mushroomed heads of impact tools; sprung wrench jaws; and missing or broken handles or guards as well as wooden handles which are cracked, splintered, or loose. All equipment and tools will be used within their rated capacities and capabilities.

4.2.2 Flammability Hazards

Due to the nature of this project, the hazards associated with flammability are expected to be low. However, the following good management practices shall apply at the site.

All electrical equipment used during the project will be inspected to ensure that it is in good repair and has no frayed or loose connections before use on site. Only approved, listed equipment and components will be used. All connections will be made in accordance with National Electric Code practices. All equipment and devices so designed will be properly grounded or bonded to an adequate grounding mechanism. Although explosive limits are not expected, only equipment listed as explosion proof will be used in areas where explosivity is sustained at or above 5 percent of the LEL.

4.2.3 Heat Stress Concerns

Heat stress is the combination of both environmental and physical work factors that contribute to the total heat load imposed on the body. Environmental factors that contribute to heat stress include air temperature, radiant heat exchange, air movement, and humidity.

The body's response to heat stress is reflected in the degree of symptoms. When the stress is excessive for the exposed individual, a feeling of discomfort or distress may result and a heat-related disorder may ensue. The severity of the response will depend not only on the magnitude of the prevailing stress, but also on the age, physical fitness, degree of acclimatization, and dehydration of the worker.

Heat stress is a general term used to describe one or more of the following heat-related disabilities and illnesses.

<u>**Heat Cramps**</u>. Painful, intermittent spasms of the voluntary muscles following hard physical work in a hot environment. Cramps usually occur after heavy sweating and often begin at the end of a work shift.

<u>**Heat Exhaustion**</u>. Profuse sweating, weakness, rapid pulse, dizziness, nausea, and headache. The skin is cool and sometimes pale and clammy with sweat. Body temperature is normal or subnormal. Nausea, vomiting, and unconsciousness may occur.

<u>**Heat Stroke**</u>. Sweating is diminished or absent. The skin is hot, dry, and flushed. Increased body temperature, if uncontrolled, may lead to delirium, convulsions, coma, and even death. Medical attention is needed immediately.

Workers will be trained on the signs and symptoms of the forms of heat stress and will be encouraged to monitor themselves and others. In addition, experience has shown that the following work/rest regimen is appropriate for field workers performing various degrees of work while wearing Level D PPE (all values are given in °C Wet Bulb Globe Temperature [WBGT]):

	Work Load		
Work/Rest Regimen	**Light**	**Moderate**	**Heavy**
Continuous Work	30.0	26.7	25.0
75% work/25% rest each hour	30.6	28.0	25.9
50% work/50% rest each hour	31.4	29.4	27.9
25% work/75% rest each hour	32.2	31.1	30.0

WBGT is defined according to the following formula (outdoors with solar load) where WB, GT, and DB are the wet bulb, globe, and dry bulb temperatures, respectively:

$$WBGT = 0.7WB + 0.2GT + 0.1DB$$

The workload classes are defined in The American Conference of Governmental Industrial Hygienists booklet, "Threshold Limit Values and Biological Exposure Indices for 1995-1996."

4.2.4 Cold Stress Concerns

Fatal exposures to cold among workers have almost always resulted from accidental exposures involving failure to escape from low environmental air temperatures or from immersion in low temperature water. Cold stress (hypothermia) and cold injury can be avoided by preventing a fall in the deep core temperature of the body.

Symptoms of hypothermia include increases in metabolic rate in an attempt to compensate for the heat loss and shivering. Workers should be protected from exposure to cold so that the deep core temperature does not fall below 36° C (96.8° F). Lower body temperatures can result in reduced mental alertness, reduction in rational decision making, or loss of consciousness with the threat of fatal consequences.

Pain in the extremities may be the first early warning of danger to cold stress. During exposure to cold, maximum severe shivering develops when the body's temperature has fallen to 35° C (95° F). **Exposure to cold shall be immediately terminated for any worker when severe shivering becomes evident.**

The body must be protected from exposure to cold air temperatures via whole body protection:

- Adequate insulating clothing must be provided to workers if work is performed in air temperatures below 40° F.
- Older workers or workers with circulatory problems must be provided with extra insulating clothing and/or a reduction in the duration of exposure.
- Gloves shall be used by all workers if the air temperature falls below 40° F.

To prevent frostbite, workers should wear insulating gloves when contact with cold surfaces below 20° F are possible. Mittens are required if the air temperature falls below 0° F.

If insulating clothing is not adequate to prevent sensations of excessive cold or frostbite, auxiliary heaters or suspension of work is required.

SECTION 5.0

EXPOSURE MONITORING PLAN

5.1 Area and Personal Monitoring

Air monitoring will be conducted to determine the presence of on-site hazardous conditions and will help determine the level of personal protection required for personnel. Environmental monitoring equipment will include a photoionization detector (PID) or a flame ionization detector (FID) for volatile organics and, if necessary, a Mini-RAM for dusts. Characterization with these instruments will determine airborne contaminants present and their concentrations in the workplace and will help assess worker safety.

5.1.1 General Area Monitoring

Area air monitoring will be conducted during all field work. The intent is to utilize generic field instruments and action levels to assess the continuous exposure to field personnel during the investigation, and to upgrade or downgrade PPE in response to the monitoring. The general monitoring shall consist of daily breathing zone monitoring every 30 minutes using the PID or FID and Mini-RAM (if applicable). In addition, upon unlocking each monitoring well, the well headspace will be monitored using a PID or FID. Daily calibration checks and maintenance of the PID or FID and Mini-RAM will also be recorded and performed according to the manufacturer's recommendations (see Appendix A for calibration documentation sheet). Breathing zone readings will be recorded in the field log book.

5.2 Action Levels

The SHO will establish daily background total organic vapor (TOV) levels (and dust levels, if necessary) prior to initiating site activities. Under most circumstances, these levels can be determined by taking multiple readings at representative locations along the perimeter of the site and averaging the results of sustained measurements.

Decisions to upgrade or downgrade personal protection will be based on sustained breathing zone TOV and/or dust levels that exceed background levels, as well as applicable regulatory exposure limits. Breathing zone refers to the area from the top of the shoulders to the top of the head. Specific criteria for upgrading or downgrading personal protection based on TOV and dust levels are presented in the following table.

Sustained Breathing Zone TOV (ppm) and dust (mg/m^3)	**Level of Protection**
Background + 5 ppm Background + 0.5 mg/m^3	**Level-D** (no respiratory protection)
5 ppm to 20 ppm 0.5 mg/m^3 to 2.5 mg/m^3	**Level-C w/ half-face respirator** (half face air-purifying respirator [APR] equipped with organic vapor/high efficiency particulate air [HEPA] cartridges)
20 ppm to 50 ppm 2.5 mg/m^3 to 5.0 mg/m^3	**Level-C w/ full-face respirator** (full-face APR equipped with organic vapor/HEPA cartridges)
Above 50 ppm or 5.0 mg/m^3	**Level-B** (supplied-air respirators)

SECTION 6.0

GENERAL SAFE WORK PROCEDURES

6.1 Personal Protection

In addition to the respiratory protection described in Section 5.0, the minimum PPE available on site shall include chemical resistant coveralls, hard hats, eye protection (i.e., safety glasses), ear plugs, inner latex or PVC gloves, outer nitrile gloves, and safety boots. It is expected that the highest level of protection which may be needed during field investigation activities will be Level C. Level C protection consists of the following:

- Full length shirt and long pants;
- Steel-toed boots or safety shoes;
- Safety glasses;
- Hard hat;
- Air-purifying respirator equipped with appropriate filter cartridges;
- Chemical resistant clothing (e.g., Tyvek, poly-coated Tyvek or Saranax suits). Suits are to be one-piece with attached hoods and elastic wrist bands;
- Outer chemical resistant gloves and inner latex surgical gloves; and
- Chemical-resistant overboots.

6.2 Work Zones and Decontamination Procedures

Work zones and decontamination procedures will be established in accordance with guidance provided in Chapters 9 and 10 of the NIOSH/OSHA/USCG/EPA document *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*. Where applicable, the

Guidance Manual for Hazardous Waste Site Activities. Where applicable, the exclusion zones will be marked with yellow caution tape. The location of the zones may be modified to fit applicable field conditions; however, proposed modifications must be approved by the HSO.

If necessary, a minimum two-basin wash/rinse station will be placed in the contamination/reduction zone to facilitate cleaning and removal of PPE. The wash/rinse station will be used by workers to clean and rinse boots and gloves. The ground beneath these basins will be covered with plastic to ensure the ground is not contaminated with basin wash/rinse water. A drum or other container will be designated to dispose of PPE that will not be reused.

It is expected that the highest level of protection used during project investigation activities will be Level C. Based on the level of expected exposure to chemical constituents, some or all of the following personnel decontamination procedures will be used as necessary:

- Station 1: Equipment Drop - Deposit equipment used on site (e.g., tools, sampling devices and containers, monitoring instruments, radios, and clipboards) on plastic drop cloths. Segregation at the drop station reduces the probability of cross-contamination. During hot weather operations, a cool-down station may be set up within this area.

- Station 2: Outer Garment, Boots, and Gloves Wash and Rinse - Scrub outer boots and gloves, and splash suit with decon solution or detergent water. Rinse off using copious amounts of water.

- Station 3: Outer Boot and Glove Removal - Remove outer boots and gloves. Deposit in container with plastic liner.

- Station 4: Canister or Mask Change - If worker leaves exclusion zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged, new outer gloves and boot covers are donned, joints are taped, and worker returns to duty.

- Station 5: Boots, Gloves, and Outer Garment Removal - Boots, chemical-resistant splash suit, and inner gloves are removed and deposited in separate containers lined with plastic.

- Station 6: Face Piece Removal - Face piece is removed. Avoid touching face with fingers. Face piece is deposited on plastic sheet.

- Station 7: Field Wash - Hands and face are thoroughly washed. Shower if body contamination is suspected.

All personnel must follow the appropriate order for cleansing and removal during decontamination: boots, outer gloves, coveralls or protective suit, respirators, and inner gloves. Direct contact with contaminated PPE can be avoided by a proper decontamination sequence. Respirators, if used, are not to be removed before leaving the contaminated area to avoid a potential inhalation hazard during decontamination.

Water, soap, and paper towels will be available for cleaning of hands and face before breaks, eating, drinking, or smoking.

6.3 General Safety Rules

In addition to the specific requirements of this SSHP, common sense should prevail at all times. The following general safety rules and practices will be in effect at the site.

- The site will be suitably marked or barricaded as necessary to prevent unauthorized visitors, but will not hinder emergency services, if needed.

- All open holes, excavations, trenches, and obstacles will be properly barricaded in accordance with local site needs. These needs will be determined by proximity to traffic ways, both pedestrian and vehicular, and site of the hole, trench, or obstacle. If holes are required to be left open during nonworking hours, they will be adequately decked over or barricaded and sufficiently lighted.

- Prior to conducting any digging or boring operations, underground utility locations will be identified. The site representative and local utility authorities (or Underground Alert) will be contacted to provide locations of underground utility lines and product piping. All boring, excavation, and other site work will be planned and performed with consideration for underground lines.

- Smoking and ignition sources in the vicinity of flammable or contaminated material is prohibited. Designated smoking areas will be delineated.

- Drilling, boring, movement and use of cranes and drilling rigs, erection of towers, movement of vehicles, and equipment as well as other activities will be planned and performed with consideration for the location, height, and relative position of aboveground utilities and fixtures, including signs, lights, canopies, buildings, other structures, and construction as well as natural features such as trees, boulders, bodies of water, and terrain.

- When working in areas where flammable vapors may be present, particular care must be exercised with tools and equipment that may be sources of ignition. All tools and equipment so provided must be properly bonded and/or grounded.

- Individuals with beards that interfere with respirator fit are not allowed within the exclusion zone. This is necessary because all site personnel may be called upon to use respirator protection in some situations, and beards do not allow for proper respirator fit.

- No smoking, eating, or drinking will be allowed in the contaminated areas.

- Tools and hands must be kept away from the face.

- Personnel should shower as soon as possible after leaving the site.

- Each environmental sample must be treated and handled as though it were extremely toxic.

- Do not touch obvious contaminated materials. Avoiding contact with these materials will facilitate decontamination.

- Persons with long hair and/or loose-fitting clothing that could become entangled in power equipment are not permitted in the work area.

- Horseplay is prohibited in the work area. The SHO has the authority to discharge site personnel for horseplay.

- Work while under the influence of intoxicants, narcotics, or controlled substances is prohibited.

Prior to the commencement of each day's activities, the HSO will conduct a daily tailgate safety meeting outlining new or potential hazards that may be encountered during site operations. The daily tailgate safety meetings will be documented by completion of the appropriate form located in the Attachment to this document.

SECTION 7.0

EMERGENCY RESPONSE/ACCIDENT INVESTIGATION

The phone numbers of the police and fire departments, ambulance services, local hospital, and ERM representatives are provided on the reference sheet at the front of this SSHP. Directions to the hospital are also provided on the sheet.

In the event of a health or safety emergency at the site, appropriate emergency measures will immediately be taken to assist those who have been injured or exposed and to protect others from hazards. The HSO will be immediately notified and will respond according to the seriousness of the injury. Personnel trained in first aid will be present during site activities to provide appropriate treatment of injuries or illnesses incurred during operations. The ERM Project Manager and Site Manager shall be immediately informed of any serious injuries.

Any accident/incident resulting in an OSHA recordable injury or illness, treatment at a hospital or physician's office, property damage, or a near miss accident, requires that an accident/incident report be completed and submitted to the ERM DISH. The investigation will be initiated as soon as emergency conditions are under control. The purpose of this investigation is not to assign blame but to determine the pertinent facts so that repeat or similar occurrences can be avoided.

7.1 Planning

Prior to facility entrance, the SHO shall plan emergency actions and discuss them with personnel conducting project work. Initial planning includes establishing the best means for evacuation from the area in case of a catastrophe.

7.2 Emergency Services

A tested system must exist for rapid and clear distress communications, preferably voice, from all personnel to the SHO. The SHO shall ensure that all personnel working at the facility know how to communicate with the appropriate local emergency response units as well as provide adequate and clear directions between work locations and the locations of support personnel, prior to commencing any facility investigation or operations. Emergency response contacts and telephone numbers are included on the emergency reference sheet.

7.3 General Evacuation Plan

In case of fire, explosion, or toxic vapor release and a site evacuation is ordered by the SHO:

- Announce the evacuation via radio/horn and notify ANG personnel and others in site buildings, then immediately call 911;
- Evaluate the immediate situation and downwind direction. All personnel will evacuate in the upwind direction;
- All personnel will assemble in an upwind area when the situation permits, and a head count will be taken by the SHO; and
- Await the arrival of qualified local emergency response personnel.

7.4 First Aid

Qualified personnel on site shall give first aid and stabilize any worker needing assistance. Life support techniques such as cardiopulmonary resuscitation and treatment of life-threatening problems such as bleeding, airway maintenance, and shock shall be given top priority. Professional medical assistance shall be obtained at the earliest possible opportunity. If assistance beyond first aid is required, call 911 and request emergency medical assistance.

A first-aid kit and emergency 16-ounce eye wash station shall be maintained readily accessible to all workers. The 16-ounce eyewash station should be supplemented by a nearby 15-minute eyewash station. Prior arrangements must be made to facilitate easy access (preferably within 10 seconds of the work area) to this 15-minute eyewash station.

Emergency first aid for organic compounds is outlined below.

7.4.1 Eyes

Flush eyes immediately with fresh water for at least 15 minutes while holding the eyelids open. If injury occurs or irritation persists, transport person to a hospital emergency room as soon as possible.

7.4.2 Skin

Wash skin thoroughly with soap and water. See a doctor if any unusual signs or symptoms or skin irritation occurs. Launder chemically-impacted clothing.

7.4.3 Inhalation

Move exposed person to fresh air. If breathing has stopped, apply artificial respiration. Call 911 immediately.

7.4.4 Ingestion

If swallowed, DO NOT make person vomit. Call Poison Control Center immediately.

7.5 Fire Protection and Response

To ensure that fire and explosion hazards are minimized, field procedures involving potential fire/explosion hazards must be coordinated with the local Fire Department. Call 911 in the event of any fire at a work location. At least one fire extinguisher with a minimum class rating of 20BC shall be provided within 50 feet of the site activities. The fire extinguisher will be inspected annually at a minimum, and the inspections will be documented on an attached fire extinguisher inspection tag.

Potential fire sources/flammable materials that may be present on site during field work include gasoline and/or diesel stored in vehicle fuel tanks, portable generator fuel tanks, and small fuel cans (for refueling portable generators). In addition, small quantities of methanol will be used for sampling equipment decontamination. Containers for flammable materials will be inspected for possible leaks or overfills at least once per day, and corrective actions will be taken as necessary to repair or replace leaking containers or to clean overfill residual from the outside of containers. Care will be taken to keep flammable materials away from potential ignition sources.

7.6 Site Control Measures

The site control measures listed below are to be followed to minimize the potential contamination of workers, protect the public form potential site hazards, and control site access.

Barricades and barricade tape will be used to delineate an exclusion zone around drilling areas. An opening in the barricades upwind of the equipment will serve as an entry and exit point. A personnel decontamination station will be established at this point. All access to the drilling location will be made at the entry and exit point.

The site will be barricaded or otherwise made secure at the end of each workday. Soils will be drummed or placed on plastic and covered. Decontamination fluids will be drummed and properly labeled.

The SHO will log all site visitors in the field notebook and will ensure that all personnel entering the work zone are briefed on site activities and potential hazards.

7.7 Site Operation Zones

The following three Site Operation Zones will be established at each investigation site:

- Exclusion zone;
- Contamination reduction zone; and
- Support zone.

The exclusion zone includes areas of active investigation or cleanup. Prescribed levels of protection must be worn by all personnel within the exclusion zone. The boundary of the exclusion zone should be a well defined physical or geographical barrier.

The contamination reduction zone serves to prevent the transfer of hazardous materials picked up on personnel or equipment in the exclusion zone.

The support zone is the outermost area and is considered a non-contaminated area. The field operations command post, first aid station, and any other investigation support activities are located in the support zone. Potentially contaminated equipment is not allowed in this area.

7.8 Emergency Operation Shutdown Procedures

In the event an extremely hazardous situation develops on site, the SHO may temporarily suspend operations until the situation is corrected or controlled. The SHO will have the authority to restart operations when the situation as been corrected and safe working conditions have been restored.

7.9 Spill or Hazardous Material Release

Spills or hazardous material releases resulting in human exposure or off-site environmental contamination are reported to the appropriate authorities by the SHO. Small spills are reported to the SHO and are taken care of per the chemical manufactures' recommended procedures.

7.10 Community Safety

Release or off-site migration of contaminants during field operations is unlikely. However, in the event of a significant release of contaminants during field work, the proper state and local authorities will be immediately notified. Appropriate actions will be taken to protect the public and control the contaminant release or migration.

ATTACHMENT 1

SAFETY AND HEALTH FORMS

The following signatures indicate that the Safety and Health Program has been read and accepted by ERM management and personnel as well as all contractors and subcontractors and their personnel.

NAME	TITLE	COMPANY	SIGNATURE	DATE

SUPERVISOR'S ACCIDENT/INCIDENT INVESTIGATION REPORT

Injured Employee:	Title:	
Date of Accident/Incident:	Dept.:	
Location:	Time on this Job:	
Engaged in what work when injured:		
Nature of accident/incident:		
How did accident/incident occur?		
What can be done to prevent recurrence of the accident?		
What has been done to prevent recurrence of the accident?		
Supervisor's Signature:	Dept.:	Date:
Reviewer's Signature:	Dept.:	Date:
NOTE: To be submitted to the Safety and Health Manager within 2 days of the accident/incident.		

ERM
DAILY TAILGATE SAFETY MEETING FORM

DATE:__________ TIME:______________ JOB NUMBER:______________
PROJECT NAME: ______________________________________
SPECIFIC LOCATION: __________________________________
TYPE OF WORK: ______________________________________
CHEMICALS PRESENT: __________________________________

SAFETY TOPICS DISCUSSED

Protective Clothing/Equipment: ______________________________
____

Hazards of Chemicals Present: ______________________________
____

Physical Hazards: ______________________________________
____

Emergency Procedures: __________________________________
____

Hospital/Clinic:______________ Phone: ______________ Paramedics: ______
Hospital Address: ______________________________________

Special Hazards: ______________________________________
____

Other Topics: ____
____

ATTENDEES

Name (printed)	Signature

ATTACHMENT 2

MATERIAL SAFETY DATA SHEETS

ISOPROPYL ALCOHOL

MATERIAL SAFETY DATA SHEET

INTEGRA Chemical Company
710 Thomas Ave SW
Renton, WA 98055
Phone: 425-277-9244

MSDS Number: 1855
Revision Date: 17-Apr-97
Revision No.: 001

Chemtrec 24 Hour Emergency Response Telephone: 800-424-9300

Product Identification

Product Name:	ISOPROPYL ALCOHOL
Synonyms:	Isopropanol, IPA, 2-Propanol
Chemical Formula:	CH3CHOHCH3
Formula Weight:	F.W. 60.10
Chemical Family:	Alcohol
Integra Product Numbers:	1855.10; 1855.13; 1855.15; 1855.19; 1855.31; 1855.50

Hazard Overview

HMIS Rating: 1-3-2-G   NFPA Rating: 1-3-0

Warning Label:

DANGER!

Highly flammable liquid. Keep away from heat, sparks and open flame. Harmful if swallowed or inhaled. Use only with adequate ventilation. Avoid contact with skin, eyes and clothing. Wash thoroughly after handling.

Components

Component	CAS #	%
Isopropyl alcohol	00067-63-0	100

Physical Data

Boiling Point:	82 °C	Specific Gravity:	0.7854 Water=1
Melting Point:	-88.5 °C	Evaporation Rate:	2.5 Butyl Acetate=1
Vapor Pressure	33 mm Hg@20°C	Vapor Density:	2.07 Air = 1

Solubility:

Miscible with water, alcohol, ether and chloroform. Insoluble in salt solutions.

Appearance and Odor:

Clear, colorless liquid. Medicinal alcoholic odor

Fire and Explosion Data

Flash Point: 53 °F   Test Method: TCC

Auto-ignition Temperature: 750 °F

Flammable Limits (% by volume in air   Upper: 12.7   Lower: 2

Fire Extinguishing Media:

CO2, Dry chemical or alcohol foam. Water may be ineffective.

Special Firefighting Procedures:

Use water to cool nearby containers and structures. Wear full protective equipment, including suitable respiratory protection.

Unusual Fire and Explosion Hazards:

Vapors may flow along surfaces to distant ignition sources and flash back.

Health Hazard Information

Effects of Overexposure

Skin Contact:

May cause skin irritation. Prolonged contact may cause dermatitis.

Eye Contact:

May irritate or burn the eyes.

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Health Hazard Information

Ingestion:

May be harmful if swallowed. Swallowing large quantities causes headaches, nausea, vomiting, stomach cramps, diarrhea and unconsciousness.

Inhalation:

Inhalation may irritate the nose, throat and upper respiratory tract. Inhalation of high concentrations may cause headache, nausea, dizziness, drowsiness, narcosis, CNS depression, difficulty in breathing. Very high concentrations may lead to pulmonary edema and unconscousness.

Chronic Effects of Overexposure:

None Identified

Exposure Limits:

	OSHA PEL		
	TWA	*STEL*	*Ceiling*
Isopropyl alcohol	400 ppm	NE	NE
	ACGIH TLV		
	TWA	*STEL*	*Ceiling*
Isopropyl alcohol	400 ppm	500 ppm	NE

Toxicity Data:

Isopropyl alcohol	LD50 (intraperitoneal, mouse)	933 mg/kg
	LC50 (inhalation, rat)	16000 ppm/8H
	LD50 (oral, rat)	5840 mg/kg
	LD50 (skin, rabbit)	13 g/kg

Medical Conditions Generally Aggravated by Exposure:

Skin disorders, eye disorders and respiratory system disease.

Target Organs:

Respiratory system, eyes, skin and central nervous system.

Reproductive Effects:

None Identified

Carcinogenicity:

None Identified

Component	NTP Listing	IARC Listing	OSHA Regulated
Isopropyl alcohol	No listing	No Listing	:

Emergency First Aid Procedures

Skin Contact:

Wash with soap and water. Seek medical attention if irritation develops.

Eye Contact:

Flush with water for at least 15 minutes. Seek immediate medical attention.

Inhalation:

Remove victim to fresh air. If not breathing, give artificial respiration. If breathing is difficult administer oxygen. Seek medical attention.

Ingestion:

Give victim large amounts of water and induce vomiting. Never give anything by mouth to an unconscious or convulsing person. Seek immediate medical attention.

Additional First aid and Treatment Notes:

ISOPROPYL ALCOHOL

MATERIAL SAFETY DATA SHEET

INTEGRA Chemical Company
710 Thomas Ave SW
Renton, WA 98055
Phone: 425-277-9244
Chemtrec 24 Hour Emergency Response Telephone: 800-424-9300

Emergency First Aid Procedures

No information available.

Reactivity Data

Stability: Stable
Hazardous Polymerization: Will Not Occur

Incompatibles:

Incompatible with strong acids and strong oxidizers. Aldehydes, amines, halogen compounds, reactive metals

Decomposition Products:

Oxides of carbon (CO, CO_2)

Conditions to Avoid:

Heat, sparks and open flame.

Spill and Disposal Procedures

Spill and Leak Procedures:

Prevent spread of spill. Absorb with sand or inert material. Sweep or scoop into a disposal container. Flush spill area with water. Eliminate all possible ignition sources. Ground all material handling equipment. Wear full protective equipment, including suitable respiratory protection.

Disposal Procedures:

Dispose in accordance with all Local, State and Federal regulations. EPA Hazardous Waste Number: D001 (ignitable waste)

Protective Equipment

Ventilation:

Use general or local exhaust ventilation to meet TLV and PEL requirements.

Respiratory Protection:

If ventilation controls do not limit airborne concentrations below PEL or TLV values, an approved respirator must be worn. Use a chemical cartridge respirator with an organic vapor cartridge.

Skin and Eye Protective Equipment:

Safety goggles, protective clothing and gloves. Maintain an eyewash station and safety shower nearby.

Storage and Handling Precautions

Storage Area: FLAMMABLE LIQUID

Store in a cool, dry, well-ventilated flammable liquids storage area or cabinet. Protect containers from physical damage. Bond and ground containers when transferring liquid.

Transportation Information

☑ *Regulated Material domestic ground transportation*

(reference: CFR Title 49, Transportation)

Proper Shipping Name: Isopropanol
UN or NA Identification number: UN1219
Packing Group: II
Hazard Class and Label: 3 Flammable Liquid
Subsidiary Risk and Label:

☑ *Regulated Material via Air Transportation*

(reference: ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air)

ISOPROPYL ALCOHOL

MATERIAL SAFETY DATA SHEET

INTEGRA Chemical Company
710 Thomas Ave SW
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Chemtrec 24 Hour Emergency Response Telephone: 800-424-9300

Transportation Information

Proper Shipping Name: Isopropanol
UN Identification Number: UN1219 Hazard Class and Label: 3 Flammable Liquid
Packing Group: II Subsidiary Risk and Label:

	Packing Instruction	Max net qty per package
Passenger Aircraft:	305/Y305	5/1 L
Cargo Aircraft:	307	60 L

Regulatory Information

Component	TSCA Inventory	CERCLA RQ	SARA EHS TPQ	SARA 313 Toxic Release de minimus
Isopropyl alcohol	☑	lbs	☐ lbs	✔ 0.1 lbs

SARA Hazard Categories:	Acute	Chronic	Flammability	Pressure	Reactivity
Isopropyl alcohol	☑	☑	☑	☐	

Clean Air Act Categories:	SOCMI	HAP	Volatile HAP	Organic HAP	Ozone Depleting
Isopropyl alcohol	☐	☐	☐	☐	

NE = Not established, NA = Not applicable or Not available

***** END OF MSDS *****

Appendix B

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN

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APPENDIX B

QUALITY ASSURANCE PROJECT PLAN

This document serves as the site-specific Quality Assurance Project Plan (QAPP) for Basewide Groundwater Assessment (BGA) activities at the Seattle Air National Guard Station (Seattle ANGS) in Seattle, Washington.

1.1 Plan Description

This QAPP presents the overall policies, data quality objectives (DQOs), specific quality assurance (QA) and quality control (QC) requirements, procedures, responsibilities, chain-of-custody procedures, laboratory analyses, and documentation that will be employed during BGA activities at the Seattle ANGS.

1.2 Basewide Groundwater Assessment Description

The purpose of the BGA project is to further define the geologic and hydrogeologic conditions at the Seattle ANGS and to evaluate whether man-made structures, historical events, or hydrologic conditions may have influenced groundwater flow beneath the Station in the past.

This QAPP provides information regarding data collection and QA procedures to ensure that the data obtained during the BGA are valid and usable for decision-making purposes.

1.3 Basewide Groundwater Assessment Objectives

This QAPP establishes standard procedures to ensure that the integrity, accuracy, precision, completeness, and representativeness of the BGA samples are maintained in order to support the objectives of the BGA. The specific objectives of the BGA are as follows:

- Characterize lithology and identify possible stratigraphic controls on contaminant migration in the southern portion of the Station;
- Characterize the lateral and vertical distribution of the dissolved VOC plume in the southern portion of the Station;
- Investigate potential VOC source areas in the vadose and saturated zones; and
- Evaluate temporal variability in the site hydrogeology and how these variations relate to the observed contaminant distribution.

1.3.1 Data Usage

The data collected during the BGA will provide the basis for decisions regarding remedial measures to ensure that concentrations of identified contaminants comply with applicable State and Federal requirements. Specifically, the data collected during the BGA will be used to:

- Characterize on-site sources of contamination, if present; and
- Further define the nature and extent of VOC contamination and possible migration pathways in the southern portion of the Station.

Additionally, the data may be used in the future to support the selection of remedial technologies and alternatives.

1.3.2 Data Quality Objectives

DQOs are quantitative and qualitative objectives for ensuring that data of known and appropriate quality are obtained during the BGA to support the intended use of the data. DQOs are selected based on the specific use of the data collected.

1.3.3 Integration of DQOs

DQOs were developed through a three-stage process. The DQO process is an integral part of work plan development that includes field screening and sampling, sample shipment to the analytical laboratory, sample analysis, and reporting. The DQO process will be revised, as needed, based on the results of each data collection activity. The general DQO development process is outlined in Table B-1.

TABLE B-1

DQO Three-Stage Development
143rd CCSQ, Seattle ANGS, Seattle, Washington

STAGE	DESCRIPTION
1	Stage 1 of the DQO process identifies the individuals responsible for decisions, data uses, and available data; and determines if additional data is needed and the types of decisions that will be made regarding site remediation. Stage 1 specifies the decision making process, identifies why additional data are needed, and sets the foundation for Stages 2 and 3 of the DQO development process.
2	Stage 2 specifies the data (quantity and quality) necessary to meet the objectives set in Stage 1. This stage stipulates the criteria for determining data adequacy. Stage 2 includes selection of the sampling approaches and the analytical options used for each site.
3	Stage 3 specifies how to assemble data collection components and develop data collection documentation. Methods were specified by which acceptable data will be obtained to make decisions. This information will be provided in the site-specific sampling plan.

1.3.4 Stages of DQOs

Stage 1 DQOs applicable to the BGA include the following:

- The Project Manager and Site Manager will be responsible for all decisions regarding actions taken to respond to field data. They are also responsible for determining personal protection levels, for example, in response to site monitoring readings by field personnel. In all cases, the health and safety of field personnel will be protected.

- The Site Manager will be responsible for ensuring that the calibration of field instruments is checked and adjusted as necessary before use each day according to manufacturers' instructions. Calibration actions will be recorded in the field log in indelible ink.

- Field-screening measurements will be used to initially characterize each site during drilling and sampling activities. If field-screening measurements identify local areas of elevated contamination, the field sampling plan may be modified by the Project Manager upon approval by the Air National Guard (ANG) Project Manager, in order to accurately assess the contamination.

Stage 2 DQOs applicable to the BGA include the following:

- The field geologist will be responsible for ensuring that the required volume of each sample matrix is collected to ensure that complete laboratory analysis objectives are met.

- The field geologist is responsible for ensuring that all QA/QC samples are collected in accordance with the field sampling plan and this QAPP.

- Personnel exposure to airborne contaminants will not exceed applicable Threshold Limit Values. Sites will be continuously screened to ensure that field personnel are not exposed to contaminants that would be harmful to their health and safety.

- Samples will be strictly controlled in accordance with ANG site investigation protocol. Samples will be collected using only decontaminated equipment. The Site Manager will be responsible for ensuring that ANG protocols for decontamination and sampling are met. In accordance with the field sampling plan, care will be taken to eliminate cross-contamination during sampling activities.

Stage 3 DQOs applicable to the BGA include the following:

- Documentation is key to ensuring that the highest levels of accuracy, precision, completeness, representativeness, and comparability are met. Accordingly, all field personnel will be trained and familiar with standard documentation requirements. Training will include information on how analytical data will be used for site investigation decisions.

- The Work Plan will be approved by the ANG prior to implementation and will include complete matrix and QA/QC sampling requirements.

- Field notes taken during sampling activities will be recorded in field log books using indelible ink.

- Samples will be labeled using a standard sample label, with all required data elements included.

- Sample data will be entered on the Chain-of-Custody Record to ensure proper sample tracking and control.

- Samples will be shipped in sealed containers and accompanied by the Chain-of-Custody Record.

- QA/QC samples, including trip blanks, equipment blanks, field duplicates, and matrix spike/matrix spike duplicates will be collected, controlled, and shipped in the same manner as normal field samples, to ensure that field collection protocols will produce accurate site data and that laboratory analytical procedures meet the highest standards of performance.

- Complete and traceable Chain-of-Custody Records will be maintained to document that proper sampling and QA/QC protocols were observed in data collection and analysis. Only traceable data will be used for decision-making regarding further sampling requirements, site remediation, or site closure.

1.4 Quality Assurance Objectives for Measurement Data

The overall QA objective is to develop and implement procedures that will ensure quality in field sampling, field testing, chain-of-custody, laboratory analysis, data analysis, and data reporting. Specific procedures for sampling, chain-of-custody, audits, preventive maintenance, and corrective actions are described in other sections of this QAPP. This section defines the numeric quantitation and QC limits for ensuring that analytical data of appropriate accuracy and precision are obtained. QC during field sampling is also discussed.

1.4.1 Regulatory Parameters

Analysis of water samples collected during the BGA will be performed in accordance with analytical procedures that conform to United States Environmental Protection Agency (USEPA) guidelines published in *Test Methods for Evaluating Solid Wastes (SW-846), Third Edition* (update package, December 1997).

Washington State soil and groundwater cleanup levels for volatile organic compounds (VOCs) and total petroleum hydrocarbons (TPH) are presented on Table B-2. The practical quantitation limits for some of the constituents listed on Table B-2 are higher than the MTCA Method B cleanup levels. The Washington State Department of Ecology (WDOE)

TABLE B-2
Washington Soil and Groundwater Cleanup Levels for VOCs and TPH
143rd CCSQ, Seattle ANGS, Seattle, Washington

ANALYTICAL GROUP	GROUNDWATER Concentration in µg/l				SOIL Concentration in mg/kg	
	Primary MCL	Secondary MCL	MTCA - Method A	MTCA - Method B	MTCA - Method A Residential/Industrial	MTCA - Method B
VOLATILE ORGANIC COMPOUNDS (VOCs)						
Benzene	5	–	5.0	**1.5**	0.5 / 0.5	34.5
Bromodichloromethane	100*	–	–	**8.7**	–	16.1
Bromoform	100*	–	–	5.5	–	127
Bromomethane	–	–	–	11.2	–	112
Carbon disulfide	–	–	–	800	–	8,000
Carbon tetrachloride	5	–	–	**0.33**	–	7.7
Chloroform	100*	–	–	7.17	–	164
Chlorobenzene	100	–	–	160	–	1,600
Ethylbenzene	700	–	30	800	20 / 20	8,000
Methylene chloride	5	–	5	–	0.5 / 0.5	–
Toluene	1,000	–	40	1600	40 / 40	16,000
Trichloroethylene	5	–	5	**3.98**	0.5 / 0.5	90.9
Tetrachloroethylene	5	–	5	**0.86**	0.5 / 0.5	19.6
Trihalomethanes (total)	100*	–	–	–	–	–
1,2-Dichloroethane	5	–	5	**0.48**	–	11
cis-1,2-Dichloroethylene	70	–	–	80	–	800
trans-1,2-Dichloroethylene	100	–	–	160	–	16,000
1,1-Dichloroethylene	7	–	–	**0.07**	–	1.67
Styrene	100	–	–	**1.46**	–	33.3
1,2-Dichloropropane	5	–	–	**0.64**	–	14.7
1,1,2,2-Tetrachloroethane	–	–	–	**1.68**	–	38.5
1,1,1-Trichloroethane	200	–	200	7200	20 / 20	72,000
Vinyl Chloride	2	–	0.2	**0.02**	–	0.53
1,1,2-Trichloroethane	5	–	–	**0.77**	–	17.5
Xylenes (total)	10,000	–	20	16,000	20 / 20	160,000
Monochlorobenzene	100	–	–	–	–	–
1,3-Dichlorobenzene	75	–	–	–	–	–
1,4-Dichlorobenzene	600	–	–	**1.8**	–	41.7
TOTAL PETROLEUM HYDROCARBONS (TPH)						
TPH as gasoline	–	–	1,000	(a)	100 / 100	(a)
TPH as diesel	–	–	1,000	(a)	200 / 200	(a)
TPH (other)	–	–	1,000	(a)	200 / 200	(a)

Sources: WDOE, 1993 and 1994
µg/l = micrograms per liter
mg/kg = milligrams per kilogram
– = Not available
MCL = Federal Maximum Contaminant Level
* MCL for total trihalomethanes including bromoform, bromodichloromethane, chloroform, and dibromochloromethane
MTCA = Model Toxics Control Act
VOCs = Volatile organic compounds
TPH = Total petroleum hydrocarbons
PQL = Practical quantitation limit
Bold typeface/shading = PQL is greater than cleanup standard
(a) = Site-specific method B cleanup levels are calculated based on *Interim Interpretive and Policy Statement - Cleanup of Total Petroleum Hydrocarbons* (WDOE, 1997)

recognizes this situation and provides guidance regarding adopting practical quantitation limits as cleanup levels (WDOE 1995).

Tables B-3 and B-4 summarize the quantitation limits for VOCs analyzed by USEPA Methods 8260 and 8010/8020. Holding times for soil and water samples are summarized in Table B-5.

1.4.2 Sampling Plan for BGA

The sampling plan for the BGA is summarized in the main text of the BGA Work Plan.

1.4.3 Quality Control During Field Sampling

Field duplicate samples and equipment rinsate blanks, field blanks, and trip blanks will be submitted to the analytical laboratory to provide the means to assess the quality of the data resulting from the field sampling program. Rinsate, field, and trip blanks will be analyzed to check for contamination associated with sampling procedures and/or ambient conditions at the site. Duplicate samples will be analyzed to assess sample homogeneity.

QC for water sample collection will include the following:

- Field duplicate samples and equipment rinsate blanks will be collected at a frequency of 10 percent of the total number of primary samples.
- One trip blank for VOC analysis will be included with each ice chest containing samples for VOC analysis. The trip blank will be prepared using laboratory reagent water.
- One tap water and one ASTM Type II water field blank will be collected for each mobilization/sampling event in which samples are collected for laboratory analysis.

Matrix spike samples provide information about the effect of the sample matrix on the analytical methodology. Matrix spike analyses are performed in the analytical laboratory. All matrix spikes are performed in duplicate. Samples designated as matrix spike/matrix spike duplicate samples are investigative samples typically collected at triple the volume

TABLE B-3

Accuracy, Precision, and PQL Limits for Method 8260
143rd CCSQ, Seattle ANGS, Seattle, Washington

Target Analyte	Soil PQL µg/kg	Soil QC Limits (a) % Recovery	Soil QC Limits (a) RPD	Groundwater PQL µg/l	Groundwater QC Limits (a) % Recovery	Groundwater QC Limits (a) RPD
Chloromethane	5			5		
Vinyl Chloride	5			5		
Bromomethane	5			5		
Chloroethane	5			5		
Trichlorofluoromethane	5			5		
Acetone	10			10		
2-Chloroethyl vinyl ether	20			20		
1,1-Dichloroethylene	5	59 - 172	22	5	64 - 124	14
Methylene Chloride	5			5		
Carbon Disulfide	5			5		
Vinyl Acetate	10			10		
1,1-Dichloroethane	5			5		
2-Butanone	10			10		
trans-1,2-Dichloroethylene	5			5		
cis-1,2-Dichloroethylene	5			5		
Chloroform	5			5		
1,1,1-Trichloroethane	5			5		
Carbon Tetrachloride	5			5		
1,2-Dichloroethane	5			5		
Benzene	5	66 - 142	21	5	67 - 127	11
Trichloroethylene (TCE)	5	62 - 137	24	5	60 - 120	14
1,2-Dichloropropane	5			5		
Bromodichloromethane	5			5		
4-Methyl-2-pentanone	10			10		
2-Hexanone	10			10		
cis-1,3-Dichloropropene	5			5		
trans-1,3-Dichloropropene	5			5		
1,1,2-Trichloroethane	5			5		
Toluene	5	59 - 139	21	5	72 - 132	13
Dibromochloromethane	5			5		
Tetrachloroethylene (PCE)	5			5		
Chlorobenzene	5	60 - 133	21	5	68 - 128	13
Ethylbenzene	5			5		
m,p-Xylenes	5			5		
o-Xylene	5			5		
Styrene	5			5		
Bromoform	5			5		
1,1,2,2-Tetrachloroethane	5			5		
1,3-Dichlorobenzene	5			5		
1,4-Dichlorobenzene	5			5		
1,2-Dichlorobenzene	5			5		

PQL- Practical Quantitation Limit
QC - Quality Control
RPD - Relative Percent Difference
µg/kg - micrograms per kilogram
µg/l - micrograms per liter
(a) - Limits should be viewed as goals and not as a means of accepting or rejecting data. QC limits apply to both matrix spike and laboratory control sample recoveries.

TABLE B-4

Accuracy, Precision, and PQL Limits for Methods 8010/8020
143rd CCSQ, Seattle ANGS, Seattle, Washington

Target Analyte	PQL µg/l	QC Limits (a) % Recovery	QC Limits (a) RPD
Dichlorodifuoromethane	5		
Chloromethane	5		
Bromomethane	5		
2-Chloroethylvinyl ether	10		
Vinyl Chloride	5		
Choloroethane	5		
Methylene Chloride	1		
Trichlorofluoromethane	5		
1,1-Dichloroethylene	1		
1,1-Dichloroethane	1		
trans-1,2-Dichloroethylene	1	20	75-125
Chloroform	1		
1,2-Dichloroethane	1	20	75-125
1,1,1-Trichloroethane	1	20	75-125
Carbon Tetrachloride	1		
Bromodichloromethane	1	20	75-125
1,2-Dichloropropane	1		
trans-1,3-Dichloropropene	1	20	75-125
Trichloroethylene	1		
Chlorodibromomethane	1		
1,1,2-Trichloroethane	1	20	75-125
cis-1,3-Dichloropropene	1	20	75-125
Bromoform	2	20	75-125
1,1,2,2-Tetrachloroethane	2		
Tetrachloroethylene (PCE)	2		
Chlorobenzene	2		
Benzene	1	20	75-125
Toluene	1	20	75-125
Ethylbenzene	1	20	75-125
p-Xylene	1		
m-Xylene	1		
o-Xylene	1		
1,2-Dichlorobenzene	5		
1,3-Dichlorobenzene	5		
1,4-Dichlorobenzene	5		

Note: Sample PQLs are matrix-dependent. The PQLs listed in the table are provided for guidance and may not always be achieveable.
PQL- Practical Quantitation Limit
QC - Quality Control
RPD - Relative Percent Difference
µg/l - micrograms per liter
(a) - Limits should be viewed as goals and not as a means of accepting or rejecting data. QC limits apply to both matrix spike and laboratory control sample recoveries.

TABLE B-5

Summary of Sample Holding Times for Water and Soil Samples
143rd CCSQ, Seattle ANGS, Seattle, Washington

Parameter	Holding Time
	Water Samples
VOCs	Analyze within 14 days of collection.
TPH	Extract within 14 days of collection and analyze within 40 days of extraction.
	Soil Samples
VOCs	Analyze within 14 days of collection.
TPH	Extract within 7 days of collection and analyze within 40 days of extraction.

VOCs = Volatile organic compounds
TPH = Total petroleum hydrocarbons

for VOCs and double the volume for other analytes. One matrix spike/matrix spike duplicate will be designated for every 20 primary samples.

QC for field measurements (e.g., pH, specific conductance, turbidity) consists of a pre-measurement calibration check and a post-measurement verification using standard reference solutions in accordance with the manufacturer's recommendations. These procedures will be performed at least once per day or more often as necessary. QC for field measurement of temperature will include measurement with a second measuring device if errant readings are suspected.

Holding times for water and soil samples are summarized on Table B-5. Holding times are defined as the maximum length of time that samples may be held before the completion of analytical protocols. Samples will be chilled in a temperature range between 2° and 4° C and will be maintained at that temperature through transport and subsequent storage at the analytical laboratory. Samples will not be retained on site for more than 24 hours unless prior approval is received from the ANG Project Manager.

1.4.3.1 Water Sample Preservation

Samples collected for VOC analysis will be preserved with no more than two drops of a 1:1 solution of hydrochloric acid per 40-milliliter glass VOC vial. The vial will have a Teflon-lined septa within the lid. VOC samples will be stored in an ice chest.

1.5 Accuracy, Precision, and Sensitivity of Analyses

The accuracy, precision, and sensitivity of laboratory analytical data must satisfy the QC acceptance criteria of the analytical protocols. Quantitation and QC limits required for aqueous and solid matrices analyzed per USEPA protocols are shown in Tables B-3 and B-4.

1.5.1 Quality Assurance Objective for Accuracy

Analytical accuracy is calculated by expressing, as a percentage, the recovery of an analyte that has been added to the sample (or standard matrix) at a known concentration before analysis and is expressed in the following formula:

$$\text{Percent Recovery} = \frac{(SSR-SR)}{SA} \times 100$$

Where

SSR = Spiked Sample Result;
SR = Sample Result; and
SA = Spike Added.

The spiked concentration will be specified by laboratory QC requirements or may be determined relative to the background concentrations observed in the nonspiked sample. In the latter case, the spiked concentration should be significantly higher (two to five times higher) than the background concentration to permit a reliable recovery calculation.

For volatile organic analysis by gas chromatography (GC) and GC/mass spectrometry, analytical accuracy is obtained from the surrogate recovery measured in each sample and blank or from the analysis of samples or blanks spiked with a select number of target analytes.

The QA objectives for surrogate recovery are summarized on Table B-6. The QA objectives for matrix spike recovery are summarized on Tables B-3 and B-4. Failure to achieve these recoveries may trigger corrective action. The recovery values for surrogate and target analytes in field sample analyses are advisory for routine laboratory analytical services.

1.5.2 Quality Assurance Objective for Precision

Analytical precision is calculated by expressing, as a percentage, the difference between the results of analysis of duplicate samples relative to the average of those results for a given analyte. Precision can be expressed by the following formula:

$$RPD = \frac{(SPL1 - SPL2)}{\text{Mean of SPL1 and SPL2}} \times 100$$

Where

RPD = Relative Percent Difference;
SPL1 = First sample value (original); and
SPL2 = Second sample value (duplicate).

TABLE B-6

Quality Assurance Objectives for Accuracy of Surrogate Spike Samples
143rd CCSQ, Seattle ANGS, Seattle, Washington

Compound/Method	Surrogate Compound	Water Percent Recovery Limits	Low/Medium Soil Percent Recovery Limits
VOCs/8260	Bromofluorobenzene	86-115	74-121
VOCs/8260	1,2-Dichloroethane-d	76-114	70-121
VOCs/8260	Toluene-d8	88-110	81-117

VOCs = Volatile organic compounds
Note: These limits are for advisory purposes only. They are not used to determine whether a sample should be reanalyzed.

The QA objectives for analytical precision are summarized on Tables B-3 and B-4. Failure to achieve these objectives may trigger corrective action.

1.5.3 Completeness, Representativeness, and Comparability

Completeness is a measure of the relative number of analytical data points that meet all the acceptance criteria for accuracy, precision, and any other criteria required by the specific analytical methods used. The percent of completeness for analytical data can be expressed by the following formula:

$$\text{Percent Completeness} = (V/T) \times 100$$

Where

V	=	Number of valid data points; and
T	=	Total number of data points.

The QA objective for analytical data completeness for the RI/FS is 90 percent. The ability to meet or exceed this objective depends on the nature of the samples submitted for analysis.

The sampling plan has been designed to provide data representative of site conditions. During development of the sampling methodologies, consideration was given to past waste disposal practices, existing analytical data, physical setting, and constraints inherent to the program.

The extent to which existing and planned analytical data will be comparable depends on the similarity of sampling and analytical methods. The procedures used to collect data for the BGA, as documented in this QAPP, are expected to provide analytical data that are comparable to the RI data.

1.6 Field Measurements

Most data collected during the BGA will be based on laboratory analysis of samples collected at the investigation site. There are certain data, such as groundwater parameters (i.e., specific conductance, temperature, turbidity, and pH) that will be collected and directly recorded in the field. The primary QA objectives for field activities should verify that QC checks are performed, measurements are obtained to the degree of accuracy consistent with their intended use, and documentation is generated to verify adherence to required measurement procedures.

Surveying and mapping at the Seattle ANGS will be conducted to provide a common frame of reference for BGA activities. Surveying will be performed by a surveyor registered in the State of Washington. Surveying of monitoring wells and soil borings will be completed to an accuracy of $\pm$ 0.1 foot horizontally and $\pm$ 0.01 foot vertically. Bench marks used during the survey will be permanent marker(s) that will be tied to National Geodetic Vertical Datum (NGVD) Mean Sea Level using either U.S. Coast and Geodetic Survey or U.S. Geological Survey monuments.

The recording of field data will follow standard reporting procedures as follows:

- Temperatures will be recorded to the nearest 0.1° C
- pH will be reported to 0.1 standard units.
- Depth to groundwater in monitoring wells will be reported to the nearest 0.01 foot.
- Photoionization detector (PID) measurements will be reported in parts per million (ppm) and will be reported with the maximum precision attainable in the instrument range scale used for the measurement.
- Specific conductance will be reported in microsiemens and will be reported with the maximum precision attainable in the instrument range scale used for the measurement.
- Turbidity will be reported in nephelometric turbidity units and will be reported with the maximum precision attainable in the instrument range scale used for the measurement.

1.7 Sampling Procedures

Procedures used for collecting environmental samples will follow standard operating procedures (SOPs) developed for Environmental Resources Management's (ERM's) Installation Restoration Program (IRP) work and will conform to ANG site investigation protocol. The SOPs are included in Appendix B of ERM's IRP Program Quality Assurance Project Plan (ERM 1995). The Site Manager is responsible for ensuring that samples are collected with properly decontaminated equipment and contained in proper sample containers with appropriate preservatives. The steps required for sample control and identification, data recording, and chain-of-custody documentation are included in the IRP Quality Assurance Project Plan.

Prior to the beginning of each sampling event, the Project Manager will meet with the assigned sampling personnel and review the purpose and objectives of the sampling. This meeting will provide final clarification of the sampling event details. Topics of review and discussion will include the following: sampling locations; types of samples to be collected; number of samples to be collected; sample identifiers; constituents to be analyzed; sampling procedures; sampling equipment decontamination procedures; and chain-of-custody documentation requirements.

Equipment decontamination is an integral part of the data collection and QA process. The implementation of proper decontamination practices and procedures will begin in the field prior to the use of sample collection equipment. Field sampling equipment will be decontaminated before and after use, in accordance with ANG protocols. Wash water and other fluids created during decontamination will be containerized and will be disposed of properly.

1.7.1 Groundwater Sampling

The following procedures will be used during groundwater sampling activities at monitoring wells:

- Immediately prior to collecting a sample, the static water level will be measured with reference to the monitoring well's measuring point and will be recorded in the field notebook.
- Whenever feasible, monitoring wells will be sampled in order of increasing concentration of contaminants, based on analysis of samples collected during previous sampling events.
- Prior to collecting a sample, water in the well casing will be purged at a rate of less than 1 liter per minute using a non-dedicated sampling pump. The temperature, pH, specific conductance, and turbidity of the purge water will be monitored during well purging using an in-line flow cell and portable water quality test meter. The purging will continue until the temperature, pH, specific conductance, and turbidity of the purge water have stabilized to within ± 10 percent. The amount of water purged from each well will be measured and recorded.

- Monitoring wells will be sampled directly from the pump discharge or with a disposable polyethylene sampling bailer. Reusable pump discharge hose will be thoroughly decontaminated before each well is sampled.

- Sampling equipment will be kept off of potentially contaminated surfaces to prevent cross-contamination of the samples (e.g., equipment will be placed on plastic sheeting).

- The calibration of the portable water quality test meter used to monitor field parameters during well purging will be checked and adjusted as necessary according to manufacturer's recommendations, at the beginning of each day and periodically during the day as required.

1.8 Sample Chain-of-Custody Procedures

Sample chain-of-custody procedures require that possession and handling of all samples be documented from the moment of its collection through the time of completion of laboratory analyses. The Chain-of-Custody Record must clearly reflect the movement of the sample through the sample handling and transport process to ensure that proper custody has been maintained and that the sample has not been tampered with in any way. A sample is judged to be in proper custody when at least one of the following criteria has been met:

- The sample is in one's actual physical possession;

- The sample is in one's clear field of view after being in one's physical possession;

- The sample is in one's physical possession and is then locked up in a secure container so that no one can tamper with it; or

- The sample is kept in a secured area that can be accessed by authorized personnel only.

1.8.1 Sample Labels

All samples will be identified with a label or permanent marker applied directly to the container. Sample identification information will be completed using waterproof ink and will consist of the following:

- Unique sample identifier;
- Time and date of collection;
- Site name;
- Preservative (if any); and
- Sampler's initials.

1.8.2 Chain-of-Custody Record

To maintain a record of sample collection, transfer between sample custodians, shipment, and receipt by the laboratory, a Chain-of-Custody Record will be filled out for all samples collected for laboratory analysis. Each time the samples are transferred, the signatures of the person relinquishing and receiving the samples, as well as the date and time of transfer, will be documented on the Chain-of-Custody Record.

1.8.3 Transfer of Custody and Shipment

Prior to the shipment of samples, the Chain-of-Custody Record will be signed and dated by a member of the field team who has verified that those samples indicated on the Chain-of-Custody Record are indeed being shipped. A copy of ERM's standard Chain-of-Custody Record is shown in Figure B-1. After packaging has been completed and the samples are closed within the ice chest, signed and dated custody seals will be placed over the edge of the ice chest lid.

Samples will be shipped by air or ground courier, or hand delivered by ERM personnel to the analytical laboratory. Samples will be transported, generally each day, by field personnel from the Station to the courier location for subsequent shipment to the laboratory. Upon receipt of the samples at the laboratory, the receiver will complete the transfer by dating and signing the Chain-of-Custody Record. An acceptable alternative is to enter the airbill number and shipping data into the appropriate signature/date block.

A copy of the airbill is to be kept with the field copy of the Chain-of-Custody Record to document specific shipping information.

Environmental Resources Management

CHAIN OF CUSTODY RECORD

NO:

915 - 118th Ave. S.E., Suite 130 ● Bellevue, WA ● 98005 ● (425) 462-8591 ● FAX (425) 455-3573

Page ________ of ________

PROJECT #	PROJECT NAME

SAMPLER: (PRINT NAME)	(SIGNATURE)

RECEIVING LABORATORY

[redacted]

MATRIX

REQUESTED PARAMETERS

SAMPLE I.D.	DATE	TIME	COMP	GRAB	SAMPLING METHOD	PRESERVATIVE	ICE (Y/N)	SAMPLING VOLUME																

RELINQUISHED BY (*SIGNATURE*)	DATE	TIME	RECEIVED BY	DATE	TIME
RELINQUISHED BY (*SIGNATURE*)	DATE	TIME	RECEIVED BY	DATE	TIME
RELINQUISHED BY (*SIGNATURE*)	DATE	TIME	RECEIVED BY	DATE	TIME

FIELD REMARKS

REMARKS ON SAMPLE RECEIPT

- ☐ BOTTLE INTACT ☐ CUSTODY SEALS ☐ CHILLED
- ☐ PRESERVED ☐ SEALS INTACT ☐ SEE REMARKS

ERM REMARKS

SEND REPORT TO:

WHITE - LABORATORY COPY   CANARY - FIELD COPY   PINK - DATABASE MANAGER   GOLD - PROJECT FILE

FIGURE B-1

Chain-of-Custody Record

143rd Combat Communications Squadron, Seattle ANGB, Seattle, Washington

1.8.4 Laboratory Chain-of-Custody Procedures

The following describes laboratory chain-of-custody procedures associated with sample receipt, storage, preparation, analysis, and general security.

1.8.4.1 Sample Receipt

Sample receipt procedures are discussed below.

- Upon receipt, the sample custodian will inspect sample containers for integrity. The presence of leaking or broken containers will be noted on the Chain-of-Custody Record. The sample custodian will sign the Chain-of-Custody Record with the date and time of receipt, thus assuming custody of the samples.

- The information on the Chain-of-Custody Record will be compared with the information on the sample labels to verify the exact sample identity. Any inconsistencies will be immediately resolved with the field sampling representative before sample analysis proceeds.

- Samples will be moved to a locked sample storage refrigerator for storage prior to analysis. The storage location will be recorded on the Chain-of-Custody Record or Laboratory Tracking Form to ensure continuity of sample tracking.

- The sample custodian will retain the original Chain-of-Custody Record and will provide copies to each laboratory section manager and one to the laboratory's sample master log.

- The sample custodian will alert the appropriate section managers and analysts of any analyses requiring immediate attention because of short holding times.

1.8.4.2 Sample Storage

Samples requiring refrigeration will be maintained in a locked storage refrigerator which will be kept at a temperature ranging from 2 to 4° C. Analytical laboratory personnel will request samples for analysis from the sample custodian and the formal transfer action, including date and signatures, will be recorded on the Chain-of-Custody Record. The analyst will then be the custodian of the sample during analysis.

1.8.4.3 Data Recording

Raw data is calculated or reduced into reportable values in three ways at the laboratory: manually, by an external computer program, and by a data system that collects the raw data. Individual laboratories have specific data recording and data management standard operating procedures. In general, data collected on an instrument's data system are transferred electronically into the laboratory's data acquisition program. Data acquisition transfers data into the laboratory information management system for routine final reporting and is also used for generation of analytical data reports. All formulae used to calculate reported values are those specified by the analytical method and are included in internal laboratory standard operating procedures.

1.9 Documentation Procedures

Documentation procedures for sample identification and field logs are discussed below. Procedures for document corrections are also discussed.

1.9.1 Sample Identification

A standardized numbering system will be used to identify water samples collected during BGA field activities. The numbering system provides a tracking procedure to ensure accurate data retrieval of all samples collected. A listing of the sample identification numbers will be maintained by the Site Manager, who will be responsible for ensuring the standardized numbering system is followed during sampling activities.

The standard sample identifiers for field samples are coded as follows:

- Sample identifiers for primary water samples will include the sampling location identifier and the depth, as applicable. For example, BGA-8-12.5 represents a groundwater sample collected from a depth of 12.5 feet in boring BGA-8.

Field QA/QC sample identifiers for water samples will be as follows:

- Sample identifiers for trip blanks will be as follows: TB-date-#. For example, TB-091300-1 represents the first trip blank collected on 13 September 2000.

- Sample identifiers for field duplicate samples will be the same as the primary sample but followed by a "D."
- Sample identifiers for rinsate blanks and field blanks will consist of the sampling location identifier at which the blank was prepared followed by an "R" for rinsate blanks, an "FT" for tap water field blanks, or an "FA" for ASTM Type II water field blanks.

1.9.2 Field Logs

Data collection activities performed at the site will be documented in bound field notebooks and on Chain-of-Custody Records using indelible ink. Field notebooks will be assigned to individual field personnel for the duration of their field activities. Entries will be as detailed and descriptive as possible so that a particular situation can be recalled without reliance solely on the sampler's memory. All field log entries will be dated and signed by the person making them.

Depending on field activities, the Site Manager may designate a member of the field team to photocopy, at the end of each day, all field notes (notebook pages and standard forms) generated during that day. Copies will be given to the Project Manager. If implemented, at the completion of a work shift, copies of all field logs, notebook pages, and standard forms will be returned to the Site Manager for subsequent delivery to the Project Manager and entry into project files.

The Site Manager will maintain a separate Site Log summarizing daily field activities, outside visitors, communications, sample shipments, and equipment assignments. This log will become a part of the original project files.

1.9.3 Corrections to Documentation

If an incorrect entry is made in any type of data document, the incorrect entry will be crossed out with a single line, the correct information entered, and the correction initialed and dated by the person making the correction. Like original entries, corrections will be made in indelible ink.

1.9.4 Final Evidence File Documentation

Records will be kept in the project files to document QA/QC activities and to provide support for possible evidential proceedings. The following outline of project file requirements applies to project activities:

Communications

- Internal
- External
- QA/QC
- Procedures
- Chain-of-Custody Documentation
- Audit Reports
- Laboratory QA Reports
- Deviation Notification Forms
- Nonconformance/Corrective Action Reports

Technical Information

- Analytical Data
- Field Data
- Field Logbooks
- Graphic Resources
- Data Quality Acceptance
- Calculations/Evaluations
- Regulatory Compliance

Project Management

- Project Schedule
- Budget
- Site Database Information

Health and Safety

- Plans/Procedures
- Audit Reports

Documents

- Plans
- Reports
- Relevant Publications

ERM will maintain all evidential file documentation using its internal project file system. Upon completion of the project, the original project files will be archived. Copies of file documentation will be provided to the ANG upon request. The Project Manager will ensure that all records, including QA/QC records, are properly stored and retrievable.

1.10 Calibration Procedures and Frequency

The following sections summarize calibration procedures for field and laboratory equipment.

1.10.1 Field Equipment

The analytical and health and safety screening instruments that may be used in the field during the BGA include:

- PID;
- Conductivity Meter;
- pH Meter;

- Turbidity Meter; and
- Temperature Meter.

The instruments will be calibrated according to manufacturers' specifications before and after each field use, or as otherwise required. Where necessary, instruments will be calibrated each day during field use.

1.10.1.1 Photoionization Detector

A calibration check of the PID will be performed at the start of each day using a standard calibration gas. Additional calibration checks and instrument adjustments will be made if the unit experiences abnormal perturbations or readings become erratic. Results of the calibration check will be recorded in the field notebook in indelible ink. Calibration procedures will follow manufacturer's instructions.

1.10.1.2 Conductivity Meter

Calibration will be performed at the start of each sampling day using a standard solution of potassium chloride. The meter will be adjusted to read the value of the standard. The meter must read within 10 percent of the standard to be considered in control and should read within 5 percent (7 percent is considered a warning level). If the calibration indicates the meter readings are out of the control limits, a backup unit should be used. If a backup unit is not available, the data will be flagged to note the percent difference between the meter and the standard calibration solution. Readings from conductivity meters lacking calibration adjustments are normally stable; thus, calibration checks are usually limited to the beginning and end of the sampling day.

1.10.1.3 pH Meter

A calibration check will be performed at the start of each sampling day using buffer solutions that bracket the pH range expected in the samples. The pH meter will be adjusted as necessary to read the value of the standard. The meter is checked during the sampling day, using at least one standard, at a frequency which results in little or no calibration adjustment. If the reading varies more than one-tenth of a pH unit between calibration checks, the frequency of the checks must be increased.

1.10.1.4 Turbidity Meter

Calibration will be performed at the start of each sampling day as necessary using a formazin solution. The turbidity meter will be adjusted to read the value of the standard. The meter is checked during the sampling day, using at least one standard, at a frequency which results in little or no calibration adjustment. If the reading varies more than one-tenth of a turbidity unit between calibration checks, the frequency of the checks must be increased.

1.10.1.5 Temperature Meter

Temperature will be measured by either using a thermostat built into the specific conductance meter or a separate thermometer unit. Temperature readings will be checked at least once per field trip as necessary using a quality-grade (preferably National Bureau of Standards traceable) thermometer. Should the unit experience erratic or out-of-tolerance readings, additional checks will be performed.

1.10.2 Laboratory Equipment

Before any laboratory instrument is used as a measuring device, the instrument response to known reference materials must be determined. The manner in which various instruments are calibrated is dependent on the particular type of instrument and its intended use. Sample measurements will be made within the calibrated range of the instrument.

Laboratory calibrations typically consist of two types, initial calibration and continuing calibration. Initial calibration procedures establish the calibration range of the instrument and determine instrument response over that range. Typically, three to five analyte concentrations are used to establish instrument response over a concentration range. Continuing calibration usually includes measurement of the instrument response to one or more calibration standards and requires instrument response to compare with certain limits (e.g., $\pm$10 percent) of the initial measured instrument response.

Specific laboratory instrument calibration procedures for various instruments are described in detail in the Laboratory Quality Assurance Project Plan for the analytical laboratory selected to perform the analyses.

1.11 Analytical Procedures

The following sections summarize the analytical procedures for field activities and the laboratory.

1.11.1 Field Parameters

As part of the analytical protocol for groundwater samples, several parameters will be tested in the field. Monitoring well purge water will be tested for specific conductance, temperature, pH, turbidity, dissolved oxygen, and oxidation-reduction potential. The field parameters will be measured using an in-line flow cell.

1.11.2 Laboratory Methods

Groundwater and soil samples collected will be analyzed using the analytical methods specified in the BGA Work Plan.

1.12 Internal Quality Control Check Procedures

The following sections summarize internal QC check procedures for laboratory analysis and field measurements.

1.12.1 Routine Analytical Services

Internal QC procedures for routine analytical services are specified in the USEPA's method descriptions. These specifications include the types of QC checks required (sample spikes, surrogate spikes, reference samples, controls, and blanks), the frequency of each audit, the compounds to be used for sample and surrogate spikes, and QC acceptance criteria for these checks.

1.12.2 Field Measures

QC procedures for field measurements are linked to checking the reproducibility of the measurements by obtaining multiple readings and by calibrating the instruments (when appropriate). QC of field sampling will involve collecting field duplicates and blanks in accordance with the applicable procedures described in this QAPP.

1.13 Data Reduction, Validation, and Reporting

The following sections summarize reduction, validation, and reporting procedures for field, technical, and laboratory data.

1.13.1 Field and Technical Data

The field and technical (non-laboratory) data that will be collected can generally be characterized as either objective or subjective data. Objective data include all direct measurements, such as field screening/analytical parameters and water level measurements. Subjective data include activity descriptions and field observations.

1.13.1.1 Field and Technical Data Reduction

As described in previous sections, field data will be recorded by field personnel in bound field notebooks and on standard forms. For example, during drilling activities, the field team member supervising a rig will keep a chronological log of drilling activities, a vertical descriptive log of lithologies encountered, other pertinent drilling information (i.e., staining, odors, field-screening results, working conditions, and water levels) in his/her bound notebook. The Site Manager may choose to appoint a team member to photocopy all field logs (including notebook pages and standard forms) generated in a given field day. Copies will be given to the Site Manager who will maintain a field log file. At the direction of the Project Manager, copies of all field logs, notebook pages, and standard forms will be returned to the office for entry into project files.

After checking the validity of data in field notes and on standard forms, the Project Manager will be responsible for entering pertinent data into project data files. Where appropriate, the data files will be set up for direct input into the project database. Subjective data will be filed as hard copies for later review by the Project Manager and for incorporation into technical reports as appropriate.

1.13.1.2 Field and Technical Data Validation

Validation of objective field and technical data will be performed at two different levels. On the first level, data will be validated at the time of collection by following standard procedures and QC checks. At the second level, data will be validated by the Project Manager, who will review the data to ensure that the correct codes and units have been included. After data reduction into tabular format or the project database, the Project Manager will review data sets for anomalous values. Any inconsistencies or anomalies discovered will be resolved immediately, if possible, by seeking clarification from field personnel responsible for collecting the data.

Subjective field and technical data will be validated by the Program Manager, who will review field reports for reasonableness and completeness. In addition, random checks of sampling and field conditions will be made by the Project Manager or Site Manager who will check recorded data at that time to confirm the recorded observations. Whenever possible, peer review will also be incorporated into the data validation process, particularly for subjective data, to maximize consistency among field personnel. For example, during drilling activities, the Project Manager or Site Manager will schedule periodic reviews of archived lithologic logs to ensure that proper lithologic descriptions and codes have been consistently applied by field personnel.

1.13.2 Laboratory Data

As described earlier, analytical data will be recorded in three ways: manually; an external computer program; and a data system that collects the raw data. Data collected on an instrument's data system are transferred electronically into the laboratory's data acquisition program. Data acquisition transfers data into the laboratory information management system for routine final reporting and is also used for production of analytical data reports. Copies of strip-chart outputs (e.g., chromatograms) will be maintained on file at the laboratory.

1.13.2.1 Laboratory Data Reduction

At the completion of a set of analyses, all calculations will be completed and checked by the analyst. The associated QC data (blanks, blank spikes, duplicates) are entered onto QC charts and are verified to be within control limits. If all data are acceptable, the data are entered into the laboratory computer system, and data summaries (including raw data) are submitted to the laboratory section manager for review. This is the procedure for all analytical data. After approval, data are subsequently entered into the project database format.

1.13.2.2 Laboratory Data Validation

In addition to the data review performed by the analysts and the appropriate laboratory section manager, an external organization to the one that generated the data will validate the analytical data. Analytical data will be reviewed by the Project Manager and assessed by a qualified chemist, using a step-by-step approach. Approximately 10 percent of the data generated by the laboratory will be subjected to validation against DQOs using USEPA validation procedures for specified analytes.

Qualified data will be annotated in accordance with USEPA Contract Laboratory Program National Functional Guidelines for Organic and Inorganic Data Review, using the following codes:

U - The analyte was analyzed for, but was not detected above the associated value.
J - The associated numerical value is an estimated quantity.
R - The data are unusable. The presence or absence of the analyte cannot be verified from the existing data. Re-sampling and re-analysis is necessary for verification.
UJ - The analyte was analyzed for, but was not detected above the reported value. The associated value is an estimate.

In addition, the following data qualifiers may be used for organic data:

N - There is presumptive evidence to make a tentative identification.
NJ - There is presumptive evidence to make a tentative identification and the associated numerical value is an estimated quantity.

1.13.2.3 Laboratory Data Reporting

Laboratory analytical results will be reported as soon as results are available and will follow USEPA requirements in order to provide defensible evidence files. The standard laboratory data reports for organic compound analysis will consist of a transmittal letter and the following:

- A cover page describing data qualifiers, sample collection, extraction and analysis dates, and a description of any technical problems encountered with the analysis.
- Sample data including quantitation limits.
- Summary of QC data, including laboratory blanks, matrix spike/matrix spike duplicates, and surrogate recovery results.

The standard laboratory data reports for inorganic constituent analysis will consist of a transmittal letter and the following:

- A cover page describing data qualifiers, sample receipt, digestion and analysis dates, and a description of any technical problems encountered with the analysis.
- Sample data including quantitation limits.
- Summary of QC data, including laboratory blanks, and matrix spike/matrix spike duplicate results.

1.14 Performance and System Audits

Audits may consist of two types: system and performance audits. The purpose of a system audit is to determine whether appropriate project systems are in place. Performance audits are used to indicate whether those systems are functioning properly. Audits will be conducted by the QA/QC Manager or a designated appointee as tasked by the Program or Project Manager, to verify the existence of an effective QA/QC system. Additionally, the audit will evaluate the level of compliance of that system in terms of adherence to QA/QC measures, standards, records, and project documentation and control.

1.14.1 Project System Audits

The QA/QC Manager may periodically, on an unannounced basis, call for a system audit. The Project Manager will respond by submitting the QAPP. The audit will be performed by the QA/QC Manager or a designated appointee. The auditor will then determine whether the QAPP is in place and whether the reviews called for by the QAPP have been performed. Results of project audits will be reported to the Project Manager and Program Manager.

1.14.2 Technical Performance Audits

Technical performance audits will be conducted by the project QA/QC Manager on an ongoing basis during the project, as field data are generated, reduced, and analyzed. All numerical analyses, including manual calculations, mapping, and computer support activities, will be documented and subject to performance audits in the form of QC procedural reviews, mathematical reanalysis, and peer review. Technical peer review is the responsibility of the Project Manager. All records of numerical analyses will be legible, reproduction quality, and complete enough to permit logical reconstruction by a qualified objective reviewer.

1.14.3 Field Audits

A field performance audit will be conducted during each phase of the investigation and will include field sampling and associated sample handling and decontamination techniques. The purpose of the field audit is to ensure that proper methods and protocols detailed in this QAPP are consistently practiced in the field.

Audits will be performed using tailored checklists prepared by the QA/QC Manager. The requirements and audit questions to be developed will be as specific as possible and will focus on significant investigation techniques. Checklists are encouraged to be completed to the maximum extent possible to give a complete picture of field techniques using a structured approach.

Field operation records will be reviewed to verify that field-related activities were performed in accordance with appropriate project procedures. Items reviewed will include, but are not limited to, field equipment calibration records, daily field logs, and chain-of-custody documentation.

Upon audit completion, an audit report containing observations, findings, and recommended corrective actions will be submitted to the Project Manager and the Program Manager.

1.14.4 Laboratory Audits

The laboratory QA manager has responsibility for monitoring the internal QA program. The contractor will verify that standardized QA programs are in effect to provide objective oversight of laboratory procedures. Additionally, copies of internal QA reports will be requested to ensure that standards of quality performance are in effect.

1.15 Preventive Maintenance

Proper preventive maintenance of field and laboratory equipment is an essential element in a successful field investigation. Implementation of standard preventive maintenance routines serves to eliminate surprise equipment failures and subsequent stand-by time.

1.15.1 Field Equipment

Field equipment will be properly calibrated, charged, and in good working condition before the beginning of each working day. Manufacturers' specifications define the required equipment checks for each type of field equipment used. Non-operational field equipment will be removed from service and a replacement will be provided immediately. Significant repairs to field equipment will not be performed in the field.

All field instruments will be properly protected during the field investigation against inclement weather. Each instrument is specially designed to maintain its operating integrity during variable temperature ranges that are representative ranges that will be encountered during working conditions. At the end of each working day, field equipment will be taken out of the field and placed in a cool, dry room for overnight storage.

Subcontractor equipment (e.g., drill rigs) will arrive at the site in proper working condition each day. Lubricating and hydraulic motor oils will be checked by the subcontractor before the start of each work day to ensure all fluid reservoirs are full and there are no leaks. Before the start of each work day, the Site Manager will also inspect subcontractor equipment for fluid leaks. If a leak is detected, the equipment will be removed from service for repair or replacement.

1.15.2 Laboratory Equipment

The ability to generate valid analytical data requires that all analytical instrumentation be properly maintained. The selected laboratory should maintain full service contracts on all major instruments. These service contracts will not only provide routine preventive maintenance, but will provide emergency repair service to ensure responsive support to the project requirements.

1.15.2.1 Instrument Maintenance Logbooks

Each analytical instrument is assigned a specific instrument logbook. All maintenance activities are recorded in the instrument log. The information entered in the instrument log will include the following:

- Date of service;
- Person performing service;
- Type of service performed and reason for service;
- Replacement parts installed (if appropriate); and
- Other information, as required.

1.16 Specific Routine Procedures Used to Assess Data Precision, Accuracy, and Completeness

The QA objectives for precision, accuracy, and completeness are discussed in Section 1.5. This section discusses the routine procedures used for assessing those criteria.

The initial responsibility to monitor the quality of an analytical system lies with the analyst. The analyst will verify that all QC procedures are followed and the results of analysis of QC samples are within acceptance criteria. If acceptance criteria limits are exceeded, this must be described in the analytical report case narrative. This requires that the analyst evaluate the results for the following laboratory QC items, as appropriate:

- Sample preparation procedures;
- Initial calibration;
- Calibration verification;
- Method blanks;
- Duplicate analyses;

- Laboratory control standards; and
- Spiked samples.

1.17 Corrective Action Protocols

The QA/QC Manager and audit team will prepare a formal report of any audit proceedings. The programmatic impact of a negative finding, such as failure to use an appropriate procedure, will be determined by the QA/QC Manager or lead auditor and reported to the project management staff. A corrective action plan and implementation schedule will be required, and the Project Manager will be responsible for ensuring that immediate action to correct the nonconformance has been initiated. The Project Manager will be responsible for ensuring the successful implementation of the corrective action plan and ensuring that no additional work that is dependent on the nonconforming action is performed until the nonconformance is corrected. Corrective actions may include reanalyzing samples (if holding times permit), resampling, and evaluating and amending sampling and analytical procedures.

The Project Manager will be responsible for ensuring that the corrective action adequately addresses the nonconformance. The QA/QC Manager will ensure that corrective actions for nonconformances are implemented by:

- Evaluating reported nonconformances;
- Controlling additional work on nonconforming items;
- Maintaining a log of nonconformances; and
- Ensuring that all Nonconformance and Corrective Action Reports are included in the project files.

Following implementation of satisfactory corrective action, the QA/QC Manager will conduct sufficient follow-up activities to verify the corrective action. Such confirmation will be documented, along with any other recommendations, in a formal close-out of the audit. The close-out report will be distributed to appropriate project management personnel.

1.17.1 Field Corrective Action

The initial responsibility for monitoring the quality of field measurements and observations lies with field personnel. The Site Manager is responsible for verifying that all QC procedures are being followed in the field. This requires that the Site Manager assess the correctness of field methods and the ability to meet QA objectives. If a problem occurs that might jeopardize the integrity of the project or cause some specific QA objective not to be met, it is the responsibility of field project staff to report suspected nonconformances by initiating a Nonconformance and Corrective Action Report (Figure B-2) and submitting it to the Project Manager.

The Project Manager will submit a copy of the Nonconformance and Corrective Action Report to the QA/QC Manager for a formal investigation. An appropriate corrective action will then be developed and implemented.

1.17.2 Laboratory Corrective Action

If the analyst's assessment of the laboratory QC items identified in Section 1.16 reveals that any of the QC acceptance criteria have not been met, as defined by the Laboratory QAPP or USEPA method protocols, the analyst must immediately assess the analytical system to correct the problem. The analyst notifies his/her supervisor, section leader, or QA coordinator of the problem, and, if possible, identifies the potential cause(s) and makes appropriate corrective action recommendations.

The identification of the corrective action obviously depends on the nature of the problem. For example, if a continuing calibration verification is determined to be out of process control, the corrective action may require recalibration of the analytical system and reanalysis of all samples since the last acceptable continuing calibration standard.

Sample-related QC samples (e.g., matrix spikes and matrix spike duplicates) provide an indication of matrix effects on analyses and do not require reanalysis if method-related QC samples (e.g., method blanks, method spikes, and method spike duplicates) indicate acceptable performance.

Nonconformance and Corrective Action Report

Date: ____________

ERM-West Project Number: ____

SUBMITTAL

To: Project Director
QA/QC Officer

Description of Nonconformance and Cause:

____

____

____

Proposed Corrective Action:

____

____

____

Submitted By:______________________ Location:______________________

Approved By:______________________ Date: ______________________

CORRECTIVE ACTION (by Project Manager or Designee):

____

____

____

Implementation by Action assigned to:

Actual Corrective Action:

Implementation verbally approved by QA Officer on __________
(date)

Action implemented on __________
(date)

____
(Signature)

VERIFICATION (by QA/QC Officer of Designee)

Corrective Action implementation reviewed and Work Inspected by:

on__________

Corrective Action Verified by on________________

Figure B-2

Nonconformance and Corrective Action Report

When the appropriate corrective action measures have been defined and implemented and the analytical system is determined to be in control, the analyst documents the problem, the corrective action, and the associated data, thereby demonstrating that the analytical system is in control. Copies of the documentation are provided to appropriate management staff members and the QA/QC Manager for review and addition to the project files.

1.18 Quality Assurance Reports to Management

The ANG Project Manager will rely on written reports and memoranda documenting data assessment activities, quality audits, nonconformances, corrective actions, and quality notices. A copy of all significant QA reports will be forwarded to the Program Director for review and oversight.

SECTION 2.0

REFERENCES

ERM. 1995. *Final Quality Assurance Project Plan, Air National Guard Installation Restoration Program.* February 1995.

USEPA. 1997. *Test Methods for Evaluating Solid Waste.* SW-846, Updated Edition. December 1997.

WDOE. 1995. *Guidance on Sampling and Data Analysis Methods.* Publication No. 94-49. January 1995.

Appendix C

APPENDIX C

BGA MEMORANDUM OUTLINE

BASELINE GROUNDWATER ASSESSMENT
TECHNICAL MEMORANDUM

APPENDIX C:	LABORATORY ANALYTICAL DATA
APPENDIX D:	QA/QC EVALUATION RESULTS
APPENDIX E:	SURVEY DATA / MAPS